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الجامعة الأردنيـــة
كلية الدراسات العليا

التاريـــخ: / /

نموذج رقم (١٨)
اقرار والتزام بالمعايير الأخلاقية والأمانة العلمية
وقوانين الجامعة الأردنية وأنظمتها وتعليماتها
لطلبة الماجستير

أنا الطالب: عدي محمد أحمد الجبوري الرقم الجامعي: (٨٠٨٠٨٥٧)
تخصص: نقل الكليـــــة: الهندسة والتكنولوجيا

عنوان الرسالة: ....
The Future of Traffic Safety in Jordan and its Impact on National Economy

اعلن بأنني قد التزمت بقوانين الجامعة الأردنية وأنظمتها وتعليماتها وقراراتها السارية المفعول المتعلقة باعداد رسائل الماجستير عندما قمت شخصيا" باعداد رسالتي وذلك بما ينسجم مع الأمانة العلمية وكافة المعايير الأخلاقية المتعارف عليها في كتابة الرسائل العلمية. كما أنني أعلن بأن رسالتي هذه غير منقولة أو مستلة من رسائل أو كتب أو أبحاث أو أي منشورات علمية تم نشرها أو تخزينها في أي وسيلة اعلامية، وتأسيسا" على ما تقدم فانني أتحمل المسؤولية بأنواعها كافة فيما لو تبين غير ذلك بما فيه حق مجلس العمداء في الجامعة الأردنية بالغاء قرار منحي الدرجة العلمية التي حصلت عليها وسحب شهادة التخرج مني بعد صدورها دون أن يكون لي أي حق في التظلم أو الاعتراض أو الطعن بأي صورة كانت في القرار الصادر عن مجلس العمداء بهذا الصدد.

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THE FUTURE OF TRAFFIC SAFETY IN JORDAN AND ITS IMPACT ON NATIONAL ECONOMY

By
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This Thesis was submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Civil Engineering

Faculty of Graduate Studies

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May, 2011

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COMMITTEE DECISION

This Thesis (The Future of Traffic Safety in Jordan and Its Impact on National Economy) was successfully Defended and Approved on May, 2011.

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DEDICATION

This work is dedicated to:

My beloved mother and father for their encouragement throughout my whole life.

My lovely wife for her emotions and support

My sons, brothers and sisters for all their support

All those who will read this research and benefit from it

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ACKNOWLEDGMENTS

I am sincerely grateful to ***Prof.Dr. khair Jadaan*** for his advice, support, guidance and assistance throughout this work. His leadership and experience provided the opportunity to achieve the goal of the research.

Many thanks to the following people and associations for their help:

Royal Jordanian Air Force
Jordanian Traffic Institute
Greater Amman Municipality
Police Traffic Department
Royal Automobile Club
Eng. Smadi, M. from RHO

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LIST OF ABBREVIATIONS

RTA	Road Traffic Accidents
JD	Jordanian Dinar
$	US Dollars
WHO	World Health Organization
AADT	Annual Average Daily Traffic
km/h	kilometer per Hour
m	Meter
MVYR	Millions of Vehicles Entering an Intersection Per Year
FIACCYR	Forecasted Number of Injury Accidents Per Year
ADT	Average Daily Traffic
VKT	Vehicle Kilometers Traveled
STL	Street Lighting
HGV	Heavy Goods Vehicles
LW	Lane Width
NL	Number of Lanes
PHF	Peak Hour Factor
S	Speed
AR	Accident Rate
GDP	Gross Domestic Product
GNP	Gross National Product
VSL	Value of Statistical Life
HC	Human Capital
WTP	Willingness -to- Pay
PGS	Pain-Grief-Suffering
VSI	Value of Serious Injury
RSS	Royal Scientific Society

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THE FUTURE OF TRAFFIC SAFETY IN JORDAN AND ITS IMPACT ON NATIONAL ECONOMY

By
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ABSTRACT

Statistics show that the fatality rate per10, 000 vehicles in Jordan is 10 times more than those in many developed countries such as U.K. Sweden, Japan, Switzerland and the Netherlands, and the number of accidents shows an increasing trend each year. In 1992, there were 20,970 traffic accidents with 388 killed. By 2007, the number of accidents had increased to 110,630 (about five times) with 992 killed, although the size of the vehicle fleet was only 841,933. The estimated cost of these accidents amounted to over JD 280 million.

This research aims at providing a better understanding of Jordan's traffic accident characteristics and trends, and evaluates their impacts on national economy. The results are used to outline some strategies to improve road safety. Potential countermeasures are evaluated by examining the attitudes of road users towards the effectiveness and favorability of these measures, in order to identify the most appropriate countermeasures.

This thesis presents the findings of a study of a substantial traffic accident database for Jordan compiled from various sources including Jordanian Traffic Institute, Insurance Companies, Ministry of Health, personal communications and interviews. In addition, a supplementary questionnaire survey was carried out to understand drivers attitudes towards potential traffic accident countermeasures.

It was found that, despite the fact that some improvement has been made, Jordan still have a serious traffic safety problem suggesting that there still quite some way to go in understanding the nature of the problem and how it should be addressed. The present impacts of road safety on national economy is estimated at about JD 336 million (2009), and expected to increase to an estimated value of JD 558 million in 2030.

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Details of a recommended national strategy of traffic safety for Jordan are presented. In addition to a number of short-term goals, the strategy has a long-term goal of achieving a level of safety comparable to those of safest countries via a change in community attitudes and creation of a “safety culture". Specific countermeasures that were perceived by road users as being the most effective and most favorable are also recommended for application. Further research to provide more insight into the road safety problem in Jordan which can help to identify more effective solution is outlined.

The results of this work will be used to influence future policy towards driving education, training and enforcement in Jordan.

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CHAPTER ONE

INTRODUCTION

1.1 Background

Road traffic accidents (RTA) constitute a major global public health resulting in over 1.2 million deaths and 15-20 million injuries annually with the driver being the main vehicle occupant involved(1).

The majority of traffic accidents (about 70 percent) occur in the low and middle-income developing countries, even though private vehicle usage is markedly lower than in wealthier nations. In developing countries, pedestrians account for about 40 percent of deaths from traffic accidents, compared with 20 percent in developed countries (2).

The level of traffic safety in Jordan falls well behind many countries and is very low compared to developed countries as the fatality rate per vehicle, for example, is approximately (8 – 9) times higher than those of the developed countries (3). The speed of economic development and population growth are expected to produce further increase in traffic volumes and consequently an increase of traffic accidents.

In Jordan, RTA constitutes an ever-growing problem of major concern. During the last thirty years, RTA increased from a total of 12,433 accidents in 1980 to 122,793 accidents in 2009. The severity of accidents has also increased but at a lower pace as the number of fatalities increased during the same period from 381 to 686 and the number of injuries increased from 4,864 to 18,842. Dividing the period to three 10-year parts shows that the annual average rates have increased from 4.3% to 11.5% and to 13.2% for the total accidents and from 4 % to 8.3% then decreased by 1.5% for the causalities (injuries + fatalities). These figures were reflected on the cost of accidents which was estimated at JD 35 million in 1980 rising to JD 258 million in 2009 (3).

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The magnitude of the problem, its rates of growth and the associated economical and social impacts are alarming and have placed it among the top priorities of government officials to the extent that a royal decree was issued in this regard. This calls for a detailed investigation into the present and anticipated future magnitude and trends, causes and associated risk factors, costs, and possible effective remedies of the problem in an attempt to curb its impact on the society.

This study provides an overview of the accident characteristics and trends in Jordan in addition to their estimated costs. A modeling process is used to predict the future accidents and their costs in order to evaluate the impact of traffic safety problem on national economy. A number of potential countermeasures are identified and their effectiveness and favorability as perceived by road users are evaluated. The results would help decision-makers to decide upon the most appropriate countermeasures for implementation purposes.

1.2 Problem Definition

A road traffic accident may be defined as any collision between vehicles, or between vehicles and moving or fixed objects along the road resulting from the interaction between the several components involved in traffic operation.

In Jordan, the financial resources are very limited with numerous number of priorities and the economic losses due to traffic accidents places further burden with an estimated cost of JD 258 million in 2009. Therefore, it is necessary to identify the magnitude and causes of the problem in order to evaluate the present and future impact of traffic safety on the national economy then recommend appropriate countermeasures for reducing this impact.

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1.3 Study Objectives

The overall of this research was to identify the nature and characteristics of RTA in Jordan, estimate their costs and identify the most appropriate remedial measures. The specific objectives of this study were as follows:

1. Providing a comprehensive analysis of RTA in Jordan, this includes a review of the scale and character of RTA in order to identify the opportunity for an action plan.
2. Estimating the present and future costs of RTA and their impact on the national economy.
3. Evaluating the preceiveness of drivers of potential accident countermeasures.
4. Recommending the most appropriate countermeasures based on the research results and other international experience.

1.4 Thesis Organization

This thesis is divided into six main chapters. Chapter 1 gives an introduction to the subject, defines the problem and states the overall objectives of the study. A detailed review of previous work related to the subject is given in chapter 2 which covers RTA characteristics, prediction and costs.

Chapter 3 gives an overview of traffic accidents in Jordan including their magnitude, trends and related issues. The chapter also presents the results of a detailed analysis of accident data for the year 2009. A comprehensive evaluation of accident costs is presented in chapter 4. It discusses the methodology used and the results of a detailed analysis of accident costs in Jordan in order to estimate the present and future costs of RTA.

The potential opportunities for action in Jordan are presented in chapter 5. These were based on international accident and countermeasures reviews and initial interpretations

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of accident data from Jordan. The chapter describes the method used and the results of an investigation carried out to examine the attitudes of road users towards the effectiveness and favorability of the potential countermeasures in order to identify the most appropriate countermeasures as perceived by road users. Finally, chapter 6 presents the conclusions of the study, recommendations to improve traffic safety and some suggested directions for future work.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The magnitude and the nature of the road safety situation in a country should include such parameters as number of accidents and the resulting causalities, a measure of risk which quantifies the probability that an accident will occur, and the cost accidents which measures the amount of resources wasted due to RTA.

Despite the fact that the magnitude of the RTA problem in developing countries is alarming, a comparatively little scientific detailed research work has been carried out in these countries in order to appropriately diagnose the associated risk factors and evaluate their present and future social and economic impacts.

This chapter presents a summary of the main literature related to the various aspects of traffic safety including accident characteristics, accidents prediction and accidents cost. The literature available in these areas is huge and, therefore, the review presented in this chapter is not exhaustive but selective focusing on the most related to the subject of the thesis.

2.2 Accident characteristics

Analyses of RTA patterns are essential in order to understand the nature of the problem and to decide upon appropriate countermeasures. It is necessary, therefore, to have sufficient information on the time, location, type, severity of accidents and the road user categories involved. Numerous researches have been carried out to identify the various characteristics of accidents such as EL-Shajrawi study in 1995.

Most accident reports do not provide adequate information to determine basic causes of accidents, but accident reports executed by police officers are normally more revealing thereby enabling adequate analysis of the characteristics and patterns of RTA.

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Accidents are not completely random events and their occurrence is governed by the interaction of various factors, and is subject to both temporal and spatial random variation which can be partly explained by variation in the factors involved.

2.2.1 Analysis of Temporal Variation (Time Series Analysis)

Time series analysis is generally undertaken primarily to help discovery and measurement of the effects of the factors contributing to accident occurrence. Temporal analysis of accident count data should consider the cyclic variations in accident occurrences which include:

1. Seasonal variations, connected with seasons of the year.
2. Daily variation.
3. Hourly variation.

The magnitude of these cyclic variations is substantial as shown in Figure 2.1 and must not be ignored. There are well established procedures for identifying cyclic variations in time series data and their effect can be removed to give "adjusted" time series data.

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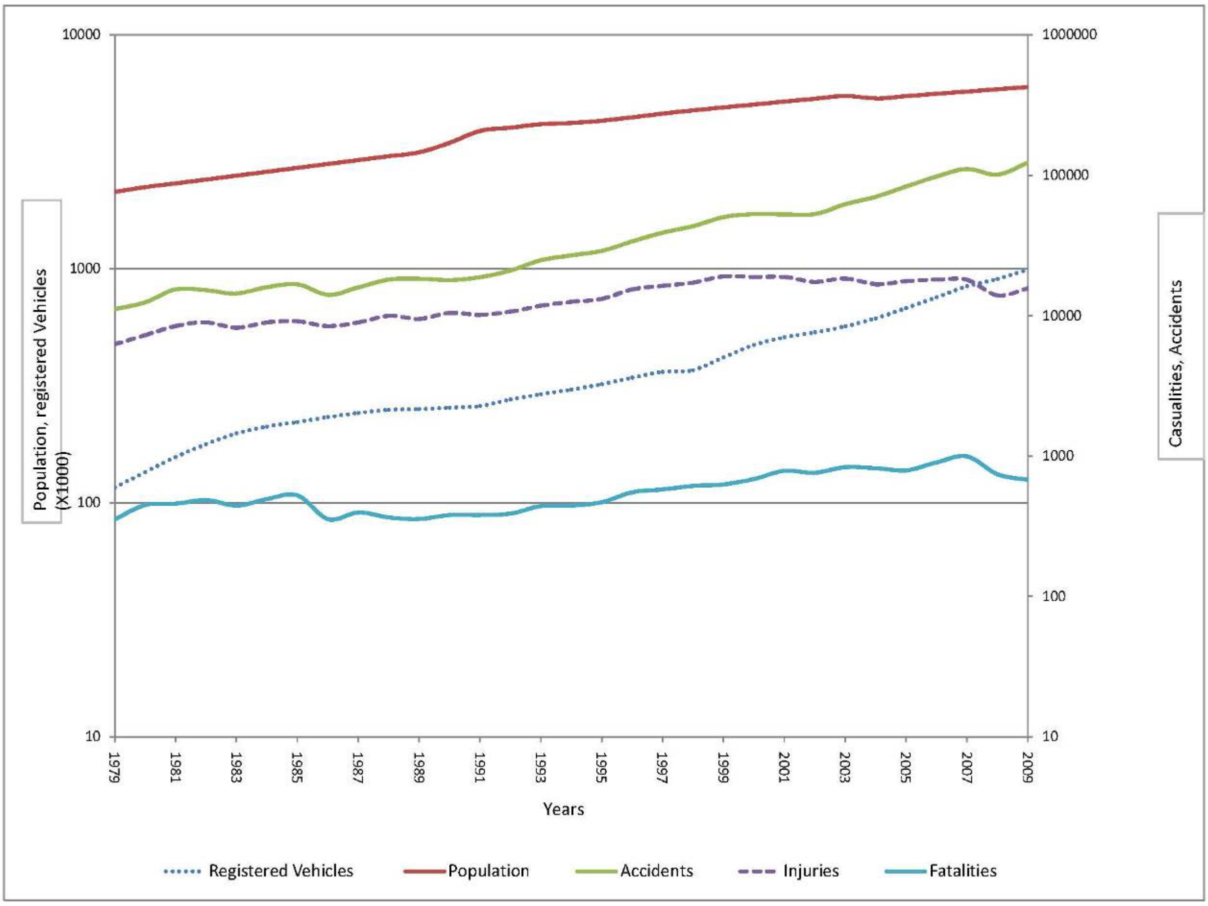


Figure (2.1) Cyclic Variations of Various Related Parameters in Jordan for the Period 1979-2009, **Ref. (3)**

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2.2.2 Analysis of Spatial Variation (Cross-Section Analysis)

An alternative to obtaining time series data at a site, involves observing accidents at several sites, along several routes or within several areas, at a point in time thus producing cross-sectional data. Such data can be analyzed in order to discover and estimate the effects of the factors contribution to accident occurrence.

With cross-section analysis, one must beware of omitting important explanatory variables and incorrectly concluding that the variation in accident occurrence is due to the variations in the explanatory variables that are included. In addition, when undertaking cross-section analysis, one must take account of the temporal variations in accident occurrence (especially the cyclic and random variation).

2.2.3 Pedestrian safety

The proportion of accidents involving pedestrians is much higher in developing countries than in developed countries. This proportion amounts to 40-80% in developing countries as compared to 15-30% in developed countries (4). This is attributed to the fact that each motor vehicle interacts with more pedestrian per Kilometer driven in developing countries than in developed countries. Other important causes can be attributed to inappropriate behavior both on the part of drivers and pedestrians and poor visibility due to the lack of street lighting and non-functioning vehicle lights.

Synder and Knoblanch (5) found that only 2% of pedestrian accidents occur at school areas. Sleight *et al.* (6) pointed out that only one of every four children killed and one in five injured were on their way to or from school.

A study in Jordan (7) indicates that there is a strong relationship between city planning criteria per zone, and total number of child pedestrian casualties per zone in Zarqa city.

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The study revealed that 79% of children pedestrian accidents occur while crossing the street.

An in depth study in1995 (8) carried out a detailed investigation of traffic accidents in Jordan taking into consideration the chain of all contributory factors with a particular attention given to human contributory factors. The study revealed the following findings that are related to pedestrians:

1. 17% of adult pedestrians admitted that they had done something which might be considered as being unexpected and contributing to an accident.
2. Of the child pedestrians of school age, 42% of the respondents reported hat they did not receive any road safety training at schools.
3. Of the 300 studied accidents, 37 (12.3%) were single vehicle, 87 (29%) involved a single vehicle and at least one pedestrian, 162 (54%) were between two vehicles and the remaining 14 (12.3%) involved a vehicle with a motorcycle, animal, etc.

2.3 Accident Prediction

2.3.1 Prediction at Roundabouts

Various researches have been carried out to investigate and predict accidents at roundabouts. One of the most comprehensive works is that by Arndt and Troutbeck (9) who applied multiple linear regression analysis to determine how much variation in the number of accidents was explained by roundabout geometry variables. Three types of accidents including single vehicle, approaching rear-end collisions and entering/circulating collisions were considered and a separate model was fitted for each type.

The single vehicle model was found to be of the form:

$$E(\mu_{single}) = 3.63*10^{-14} * Q* L*(S+\Delta S)^{2} \{(S+\Delta S)^{3}/ (R^{1.5} +47.4)\}$$

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Where:

- $E(\mu_{single})$ = expected annual single-vehicle accident frequency.
- Q = annual average daily traffic (AADT) in the direction considered.
- L = length of vehicle path on the geometric element (m).
- $S = 85^{th}$ percentile speed on the geometric element (km/h).
- ΔS = decrease in S at the start of the geometric element (km/h). - R = radius of the geometric element.

The approach rear-ends collision model fitted to the data was of the following form,

$E(\mu_{rear\text{-}end}) = 0.62 * 10^{-11} * Q_a * Q_c^{0.5} * S_a^2$

Where:

$E(\mu_{rear\text{-}end})$ = expected annual rear-end accident frequency

Q_a = AADT on the approach (one-way traffic)

Q_c = AADT on the circulating carriageway adjacent to the approach (one-way traffic)

$S_a = 85^{th}$ percentile speed on the approach curve (km/h)

As for the entering- circulating collisions, the following model was developed:

$E(\mu_{entering}) = 3.45 * 10^{-12} * Q_a * \Sigma (Q_{a*} S_{ri}^2)$

Where;

$E(\mu_{entering})$ = expected annual accident frequency involving entering and circulating vehicles.

Q_a = AADT on the approach (one-way traffic).

Q_{ci} = AADT for each of the *i* movements on the approach entrance curve and on the circulating carriageway adjacent to the approach.

$S_{ri} = 85^{th}$ percentile speed for each of the *i* movements on the approach entrance curve and on the circulating carriageway adjacent to the approach (km/h).

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2.3.2 Prediction at Signalized Intersections

Lau and May (10) developed accident prediction models for signalized intersections based on several characteristics of 2,500 signalized intersections. The analysis started at a level where only traffic intensity expressed in millions of vehicles entering an intersection from all approaches (MVYR) is considered for the prediction accident models. The following model was developed to estimate the forecasted number of injury accidents per year (FIACCYR):

FIACCYR = 0.61856 + 0.16911*MVYR.

As a result of their study, the following factors have been found to be significant: traffic intensity, proportion of cross street traffic, intersection type, signal type, number of lanes, and left turn arrangements.

A recent study by Marchionna, et al. (11) established accident models to predict the number of accidents at three-leg and four-leg signalized urban intersections in Denmark as accurately as possible. Using a generalized linear modeling technique and assuming Poisson distribution of accidents, he employed a model of the form,

$$\mu_i = \alpha \cdot N_{pri}^{p1} \cdot N_{sec}^{p2} \cdot \exp \Sigma\, \beta_j \cdot x_{ij}$$

Where;

- μ_i is the expected number of accidents at the i^{th} intersection per year.
- N_{pri} is the incoming traffic flow (ADT) from the primary direction
- N_{sec} is the incoming traffic flow (ADT) from the secondary direction
- x_{ij} the variables describing road geometry or environment of the intersection.
- α , p, β_j are the parameters to be estimated.

The statistical analysis showed that the variables describing road geometry do not significantly increase the percentage explained, therefore the models developed shown in table 2.1 use only traffic flows as independent variable.

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Table (2.1) Accident Prediction Models for Signalized Intersection

Type of Signal / Model Parameter	3 leg signalized	4 leg signalized
A	1.34E-05	1.08E-4
p1	0.88	0.53
p2	0.33	0.52

Source: Ref. (11)

2.3.3 Prediction along Arterials/ Freeways

The importance of freeways accident modeling arises from the frequency and severity of these accidents and the congestion associated with them.

Chatterjee et al. (12) presented a method to estimate the relationship between accidents and trip length on freeways. They argue that freeways have better geometric conditions than other roads and that driving on freeways more than two hours causes high possibility to sleepy driving.

An accident prediction model was then developed showing a strong relationship between traffic accidents rate on freeway exits(Y) being the dependent variable and the Potential Accident Ratio (X_1) and traffic volume per lane(X_2) as independent variables. The following non-linear model was found most appropriate:

$$Y= -23.979 - 5.046 X_1 + 7.7556 X_1^2 + 5.828 (\ln X_2) – 0.339 (\ln X_2^2)$$

This freeway accident model can constitute a useful decision support tool for analysis of traffic accident and the implementation of freeway patrol systems.

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Pilko et al. (13) endeavored to study the safety of urban freeway interchange spacing defined as the distance between intersecting streets with freeway ramps. They developed a model of the following form:

$$FI_{CA,WA}=y*e^{(-13.3269+1.3687LN(AADT/LANE)+0.6184LN(SPACING)+0.2632LN(RAMPAADT - 0.0032*MEDWID)}$$

Where:

- FI is the fatal/injury accidents within the freeway interchange spacing segment (that is, all accidents except property damage only ones).
- AADT is the annual average daily traffic of the freeway section measured at the midpoint of the section.
- AADT/Lane is the freeway AADT divided by total number of lanes (NUMLANES) at the midpoint of the section. Number of lanes includes through lanes plus HOV and other auxiliary lanes greater than 0.32 km (0.2 mi) long.
- SPACING is the segment length from crossroad to crossroad.
- RRATIO is total RAMP AADT divided by Freeway AADT. Total ramp AADT is calculated by adding the total onramp AADT and total off ramp AADT regardless of the ramp type-diamond, clover leaf, partial cloverleaf, or directional within the spacing segment.
- MEDWID is the median width in feet.
- MEDTYP is the median type. It equals 0 for paved median, and 1 for unpaved median.
- y is the number of years.
- LN is the natural logarithm.

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2.3.4 Area-wide Prediction

Few studies have developed models at a more aggregate zonal level that could be used as part of the transportation planning process. The following paragraphs describe some of these studies.

Hadayeghi et al. (14) aimed to develop a series of macro-level accident prediction models that would estimate the number of accidents in planning zones based on the City of Toronto's 463 traffic zones and for the year 1996 only. A generalized linear modeling approach was employed in which Negative Binomial regression models were developed separately for total accidents and for severe (fatal and non fatal injury) accidents. The variables that were found to have significant effects on accident occurrence include major road kilometers (X_1), the number of households (X_2), posted speed (X_3), volume-capacity ratio (X_4), intersection density (X_5), in addition to vehicle

The Total Yearly Accident Model is of the form:

$$E(A) = 4.1767 *(VKT)^{0.2656} * \exp(0.1175 * X_1 + 0.0864 * X_2 -0.0431 * X_3 -1.3678* X_4+0.0052 * X_5)$$

And the Yearly Severe Accident Model:

$$E(A) = 2.6618*(VKT)^{0.2415} * \exp(0.1225*X_1 + 0.0858*X_2 - 0.0312*X_3 - 1.2232*X_4 + 0.0038 *X_5), (R^2=0.3306)$$

Where; E (A) is the predicted accident frequency.

Modeling results showed that the number of accidents per zone in a year increases as the zonal VKT, major and minor road kilometers, total employed labor force, household population and intersection density increase, and decreases with higher posted speed and higher congestion in the zone.

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2.3.5 Prediction in Developing Countries

Limited work has been carried out on accident prediction in developing countries. The following paragraphs give a summary of selected studies in various developing countries.

Salifu (15) developed accident prediction models for un-signalized urban junctions in Ghana, which account for more than 60 percent of all junction accidents in Ghana. The model development process utilized 3-year (1996-1998) traffic, road and accident data for 91 junctions contained 57 three-arm junctions (T- junctions) and 34 four-arm junctions (X-junctions) selected from the two most cosmopolitan cities in Ghana. Negative Binomial models of accident frequency were developed separately for T- and X-junctions. The best fitting model identified for X-junctions was found to be of the following form:

$$A = 8.12x10^{-5} * CFPD^{0.370} * e^{(0.580STL\ (2)\ +0.661LFT\ (2)\ +0.190HGV+0.134JNEC+0.100SSD)}$$

Where;

- LL (0) is the Log-likelihood value for null model
- CFPD is the Crossing flow products and is obtained by summing up all products (multiplication) of each pair of traffic flows (expressed as AADT), whose normal paths through the junction cross each other.
- STL is the street lighting. It equals 1 if present and 2 if absent.
- LFT is the Left-turning storage lane on major. It equals 1 if present and 2 if absent.
- HGV is the proportion of heavy goods vehicles and buses as a percentage of total traffic inflow
- JNEC is the average width of minor road at neck of junction (m).
- SSD is the average standard deviation of vehicles approach spot speeds (km/h).

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The best fitting model identified for T-junctions was found to be as follows:

$A = 1.01*10^{-3}\ XPDF^{0.514}\ e^{(0.0694SSD-0.465TCON(2)-0.952TCON(3)-0.151MEDW)}$

Where;

- LL (0) is the Log-likelihood value for null model
- A is the expected 3-year frequency of accidents at T-junctions.
- XPDF is the cross product of flows (i.e. product of the major (MAJF) and minor (MINF) road daily in flows).
- TCON is the parameter representing traffic control on the minor road and it equals to 1 if a stop control is present, 2 if a yield control is present and 3 if no control is present.
- MEDW is the average width of the median on the major road.
- SSD is the average standard deviation of vehicle spot speeds on the major approaches.

The models can be used subsequently, for the reliable prediction of accident frequency associated with the junction types and features described. Their use in this manner will facilitate a more proactive and cost-effective management of traffic safety and accident black spots in the urban environment.

Jadaan et al. (16) developed accident prediction models using time-series data of road fatalities, vehicles and population for Saudi Arabia between 1974 and 1987. Regression analysis (least square method) was used and the model was found to have the following form:

$D = \ln (N^{849.3}\ P^{-608.1})$

Where:

D= number of fatalities

N= number of vehicles

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P= population.

The correlation coefficient being R^2=0.85, calculating the deviation of the estimated fatalities from the true values produced an average absolute percentage error of only 7.67.

Recent work by Jadaan and Al-Matawah (17) investigated the application of prediction techniques to road safety in developing countries. They produced a prediction model for traffic fatalities using a regression analysis of time-series fatality data from the UAE, Jordan and Qatar for the period (1990-2004).

The natural logarithmic model for the selected developing countries is:

$$D=e^{1311.872} * V^{384.502} * P^{-420.486}$$

Where:

D is the number of road fatalities

V is the number of vehicle

P is the population of the country.

Comparing the actual and predicted number of fatalities, it was found that the average absolute percentage errors were 5.5, 20.0 and 4.8 for UAE, Qatar and Jordan respectively.

The same technique was applied to Kuwait, which is a rich developing country. Accident data were collected using a pre-designed survey questionnaire. The model used the number of accidents a driver had been involved in over the period (1998-2008) as the dependent variable (A) and the number of independent variables believed to have a significant effect on accidents in Kuwait, including age, nationality, marital status, aggressive driving behavior score, usual speed on motorways, years of driving experience, and effectiveness of enforcement.

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The developed Generalized Linear Model was found to have the following form:

$\mathbf{A}= 0.198\ (\text{Exposure})^{0.135}\ \mathbf{.}e^{-0.0246\mathbf{B}+0.31\mathbf{C}-0.433\mathbf{D}+0.18\mathbf{E}+0.06\mathbf{F}-0.161\mathbf{G}-.0386\mathbf{H}+0.204\mathbf{I}}$

The resulting identified effects of the contributory factors are summarized as follows:

a. Age (B): the younger the age, the greater the number of accidents.

b. Nationality (C): Kuwaitis were involved in more accidents than were non-Kuwaitis.

c. Marital status (D): single drivers were involved in more accidents than married drivers.

d. Speed (E): speeding on motorways leads to more accidents.

e. Number of dangerous offences per year (F): the greater the number of dangerous offences per year, the higher the number of accidents.

f. Aggressive driver behavior score (G): the more aggressive the driving, the greater the number of accidents.

g. Experience (H): the more experienced the driver in terms of number of years driven, the less involvement they have in accidents.

h. Effectiveness of enforcement (I): drivers who think that enforcement is ineffective experience a greater number of accidents compared to drivers who perceive enforcement to be effective.

In addition to the above, a number of traffic accident prediction models for developing countries including Arab countries were developed and examined using various techniques. Below is a summary of some of these models.

1. $D/V = 0.00052(V/P)^{-0.6}$

For Gulf and Middle Eastern countries (18).

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2. $D = Ln\,(V^{299.8} \cdot P^{-249.0})$

For Kuwait (19).

3. $D = Ln\,(V^{849.3} \cdot P^{-608.1})$

For Saudi Arabia (20).

Where:

D = number of fatalities, P = population and V = number of registered vehicles

Models to predict accidents in Jordan have also been developed. These are discussed separately in the following section.

2.3.6 Prediction in Jordan

Limited work of aggregate nature was carried out on prediction of accidents in Jordan. Abo-Qudais developed accident prediction models for urban roads in the city of Irbid in Jordan. For this purpose he randomly collected data for 76 road sections in Irbid each >800m long with a total length of 86.2 km. This minimal length corresponds to the value reported by Martine et al. (21). For the chosen street sections all variables related to road, traffic and environment, which were expected to have an effect on the accidents rate (in accidents per million vehicle kilometers), were collected for the years 1996, 1997 and 1998.

The statistical analyses indicated that lane width (LW) is the most significant parameter, followed by number of lanes (NL), the average annual daily traffic (AADT), road surface condition, peak hour factor (PHF), and speed (S). Interaction between night or day and number of lanes and PHF, road surface condition and PHF, and time of day and whether the street is one-or two-way were also found significant.

The various models that correlate accident rate to the individual factors were found to be as follows:

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$AR=0.125*LW^3-1.1673*LW^2+1.5027*LW+9.274$, ($R^2=0.2925$),

$AR=0.1525*NL^3-1.7673*NL^2+5.3666*NL+1.1639$, ($R^2=0.263$)

$AR=162.62*ADT^{-0.4303}$, ($R^2=0.331$)

$AR=-260.27*PHF^3+931.23*PHF^2-1061.2*PHF+394.59$, ($R^2=0.2319$)

$AR=0.0004*S^2+0.0619*S$, ($R^2=0.2326$)

Where;

AR is the accident rate (accidents per million vehicle kilometers).

ADT is the average daily traffic.

Besides the separate models stated above, also models were derived which relate the different geometric, traffic and environmental parameters to the accident rate. The relationship between accident rate and the different explanatory variables was best represented by the multiplication models which were developed on two levels. Models of the first level relate the accident rate to all significant variables.

For models of the second level, the accident rates were disaggregated into a number of categories, according to number of lanes (one, two, three, four or six lanes), ADT (less or more than 4,000 vehicles per day) and speed ranges (less or more than 50 km/h).

Models at both levels were of the following form:

$$AR=a*X_1(b*e^{c.ADT})\ (d*S^3+e*S^2-f*S)\ (g*LW^3+h*LW^2-i*LW)*\ (j*NL^3+k*NL^2-l*NL)\ m*PHF^n.$$

Where:

X_1 is a constant equal to 1.00 for dry surface condition and 3.118 for wet surface condition. The other coefficients from (a-n) were also estimated.

Comparison of the models indicated that models of the second level have better statistical properties and prediction capability compared to the models of the first level. In order to validate the models, they were applied to a different set of data. This

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comparison showed a good agreement between the predicted values and the actual values.

Al-Haj Yaseen (22) has developed accident prediction models for Amman-Jordan to forecast road accidents of various types: total, collision, run over and turn over accidents, and their consequences. Twenty two road sections were selected representing different traffic characteristics. The accident, injury, fatality data were for the period (2002-2004). Different types of regression were used to find the best fitting model.

The considered predictor variables were average running speed (S), annual average daily traffic (AADT), and road section length (L). The study produced the following models for the various types of accidents and resulting casualties:

- The best equation found for predicting the number of total accidents (T) is:

$T= 229+ 0.2689*V + 66.58*L – 3.215*S$

- The best equation found for predicting the number of collision accidents (C) is:

$C= 219.65+ 0.1133*V+ 61.73*L – 3.022*S$

- The best equation found for predicting the number of injuries (I) is:

$I= 2.74+ 0.269*L*V$

The best equation found for predicting the number of fatalities (F) is: -

$F= -0.22+ 0.0795*L^3+ 0.00000471*V^3$

- The best equation found for predicting the number of run over (R) is:

$R= Exp (2.181+ 0.015*V+ 0.178*L – 0.0138*S)$

- The best equation found for predicting the number of turn over (N) is:

$N= Exp (-0.146 – 0.008*V+ 0.693*L)$

It was found that the average prediction error for most of the developed models lies between (30-40%) indicating that fatalities, injuries and accidents data depend on a

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wide range of factors such as driver behavior, vehicle characteristics, road geometry and others, in such a way that prediction made from two or three independent variables, may lead to larger errors. Furthermore, all developed models are static models. This means that any change in geometric or conditions along the sections will limit the use of the prediction models.

Most recently a prediction model was developed to estimate traffic fatalities based on three independent variables (23). The model has the following form:

$$F = -1114.8 + 0.000243\,P - 0.000312\,V + 0.103L, \qquad R^2 = 0.836.$$

Where:

F is the number of fatalities,

P is the population,

V is the number of registered vehicles,

L is the total length of paved roads (km).

The value of (R^2) indicates that 83.6 percent of road fatalities in Jordan can be explained by the developed model through the independent variables; population, number of registered vehicles and total length of paved roads.

2.4 Accident Costs

2.4.1 Introduction

Several previous studies investigated various types of accident costs. Different types of studies have different purposes, which affect their perspective, methodologies and scope. For example, most accident cost studies are primarily concerned with direct market costs, such as hospital and accident damages. When comparing cost estimates the following main factors should be considered (24):

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1. The purpose of the analysis and its perspective.
2. Data sources and methodologies used to calculate the costs.
3. Geographic scope, and monetary exchange rates used in different countries.
4. The time period evaluated and index used for inflation.

The following section reviews a number of related studies in developed and developing countries.

2.4.2 Previous Cost Estimates and Studies

Estimates of per mile accident cost vary widely. Studies that only examine external costs produce lower values and comprehensive studies result in higher values. A summary of cost per distance studies is shown in Table 2.2. Analysis using macro-level collision prediction models (25) suggest that improving transportation options through measures such as better walking and cycling conditions, improved ridesharing and public transport services could reduce accident frequency by 14% and severity by 15%.

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Table (2.2) Accidents Cost Estimate Summary Table – Selected Per Distance Studies

Publication	Costs	Cost Value ($/KM)	2007 (USD/Mile)
Miller 1994	Average car-comprehensive Bus Motorcycle	0.121994 USD 0.32 0.150	0.17 0.45 2.10
Cambridge Systematic 2008	Comprehensive-Urban	0.25-0.41 2005USD	0.27-0.43
Parry 2004	External	0.022-0.066 2004 USD	0.02-0.07
PHWA 1997	External – Rural External – Urban	0.017-0.095 .008-0.04 1997 USD	0.02-0.12 0.01-0.05
NHTSA 2002	Market	0.086 2000 USD	0.10
Wang, Knipling & Blincoe 1999	Comprehensive – Cars	0.248 1997 USD	0.32
NZ Ministry of Transportation 2006	Average – assumed external	0.06 2006 NZD/Km	0.06

Source: Ref. (25)

A Swiss government study (26) estimated the 1998 RTA costs to be 9.7 to 12.3 billion Swiss Francs (CHFs) with around 1.5 billion remaining as external costs borne the general public (non-users). Another study (27) summarized accident costs studies by travel mode as shown in Table 2.3 below concluding that accident costs per passenger mile is about 10 times higher for cars than for buses.

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Table (2.3) Accident Costs by Travel Mode (U.S. dollars)

Study	Location	Passengers(pass.-Km)			Freight(tone-Km)		
		Car	**Bus**	**Rail**	**Road**	**Rail**	**Water**
Planco,1990	FRG	0.020	0.004	0.003	0.012	0.008	0.000
Tefra, 1985	France				0.007	0.000	
Ecoplan, 1991	Switzerland	0.030	0.007	0.004	0.070	0.001	
Hansson,1987	Sweden, Urban	0.050	0.013	0.001	0.013	0.000	
Hansson, 1987	Sweden, Rural	0.008	0.001				

Source: Ref. (27)

The American Automobile Association study (28) compared accident and congestion costs in major U.S. cities found that accident costs average more than twice congestion costs. And that urban accident costs are estimated to average $25 - $41 per vehicle mile. A survey of U.S. Department of Transportation (DOT) to determine the accident costs values used for traffic safety evaluation produced the results shown in Table 2.4 below (29).

Table (2.4) DOT Accident Cost Values by Severity and State

State	**Fatal**	**Injury**	**PDO**
Texas	$ 1,191,887	$ 69,199	$ 1,969
Wisconsin	$ 1,057,000	$ 50,300	$ 6,600
Illinois	$ 1,040,000	$ 36,000	$ 6,500
North & South Dakota	$ 1,040,000	$ 36,500	$ 6,500
Connecticut	$ 1,040,000	$ 36,500	$ 6,500
Michigan	$ 1,000,000	$ 35,300	$ 6,500
Ohio	$ 987,977	$ 39,258	$ 6,480

Source: Ref. (29)

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Estimates of productivity and comprehensive costs of RTA were published by the U.S. National Safety Council (30) as shown in Table 2.5. Productivity costs include lost wages, medical expenses, motor vehicle damage and employers uninsured costs, which comprehensive costs include victims pain and people's willingness to pay to avoid such injuries.

Table (2.5) Accident Costs by Severity

	Economic Productivity Costs	Comprehensive Costs
Death	$1,130,000	$3,760,000
Non-fatal disabling Injury	$49,700	$188,000
Non-incapacitating Evident injury		$48,200
Possible injury		$22,900
Property damage accident(including non disabling injuries)	$7,400	$2,100

Source: Ref. (30)

Another study by Parry (31) calculated total and external accident costs for various accident severities as shown in Table 2.6 "Quality of life costs" represent the value of non–monetary costs such as pain and grief.

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Table (2.6) Accident Cost Components by Severity (2004 U.S.dollars)

	Fatal Injury	Disabling Injury	Evident Injury	Possible Injury	Property Damage Only
Medical	$22,2095	$19,471	$5,175	$3,485	$140
Household Productivity	0	$6,944	$1,854	$1,244	$85
Lost Wages	0	$25,014	$6,239	$4,160	$155
Legal Costs	$102,138	$5,167	$1,101	$681	$15
Insurance Administration	$37,120	$5,999	$1,776	$1,181	$152
Property Damage	$10,273	$4,357	$3,824	$3,413	$1,642
Police &Fire Services	$833	$175	$112	$90	$31
Travel Delay	$5,247	$885	$797	$785	$696
Employer Costs	0	$1,679	$665	$461	$67
Total, Excluding Quality of Life Costs	$186,480	$69,479	$21,543	$15,500	$2,983
Quality of Life Costs	$3,000,000	$83,239	$19,560	$10,725	$464
Total, Including Quality of Life Costs	$3,186,408	$152,718	$41,103	$26,225	$3,447

Source: Ref. (31)

In Australia, the total cost of RTA in 1996 has been conservatively estimated at approximately $15 billion (32). This includes vehicle and property damages, emergency services, traffic delays, medical costs, lost productivity and lost quality of life. The average cost of fatal accident was estimated at $1.7 million; serious injury accident, $408,000; minor injury accident, $14,000 and property damage only accident (PDO), $6,000.

A study by the New Zealand Ministry of Transport (33) estimated the social costs imposed by RTA in 2005 to be about $4.1 billion (New Zealand dollars). These included &1,241 million for fatalities, $1,353 million for serious injuries, $713million

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for minor injuries and $800 million for property damages. The cost of RTA averages about $1000 per capital or $6 per vehicle-Kilometer.

In U.K. the Transport Analysis Guidance (TAG) published by the Department of Transport (34) included values for prevention of causalities and accidents, with explanations of the basis of these estimates. A summary of these values in 2007 is shown in Table 2.7 in British pounds.

A European Union Study (35) provides estimates of RTA costs as detailed in Table 2.8.

Table (2.7) Average Value of Prevention per Casualty by Severity in U.K

Injury Severity	Lost Output	Human Costs	Medical & Ambulance	Totals
Fatal. A death occurs within 30 days from causes arising out of the accident	£556,660	£10,990	£970	£568,620
Serious. Casualties require hospital treatment and have lasting injuries but live at least 30 days.	£21,830	£150,180	£13,230	£185,220
Slight. Injuries requiring no hospital treatment or Injury effects quickly subside.	£2,310	£10,990	£980	£14,280

Source: Ref. (34)

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Table (2.8) Accident Costs (2003 Euros)

	Lost Output	Human Costs	Medical Costs	Property Damage	Insurance Admin.	Police Costs	Delay Costs	Total Costs
Fatal Accident	598,408	1,150,000	8,056	11,172	344	1,999	15,000	1,789,754
Injury Accident	6,632	35,000	3,524	3,445	130	91	5,000	53,736
Individual Fatality	520,355	1,000,000	7,005	*NA	NA	NA	NA	1,527,360
Individual Injury	4,877	26,000	2,591	NA	NA	NA	NA	33,468

Source: Ref. (35)

* NA = Not Applicable

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2.4.3 Previous Accident Cost Studies in Jordan

A number of attempts have been made and studies carried out over the

past years to evaluate accident costs in Jordan using various approaches. However, much of the work done has aimed at developing aggregate cost figures. The main evaluation may be summarized as shown in Table 2.9.

Table (2.9) Various Studies of Cost Estimation in Jordan

Study	Year	Cost in Million
Royal Jordanian Society (RSS)	1980	JD 12.6
Group of Eng. & ECN	1981	JD 63.1
Private Consultant	1981	JD 11.0
Public Security	1985	JD 41.4
Jadaan (medical cost)	1989	JD1.21
Public Security	1990	JD40.0
AL-Omary	1990	JD 52.8
Al-Mashakbeh	1996	JD 104.7

A financial cost trend for the period (2000-2009) in Jordan shown in Figure 2.2 was published by the Jordanian Traffic Institute. The cost estimates were based on Al-Mashakbeh work (36) as shown in Figure 2.2.

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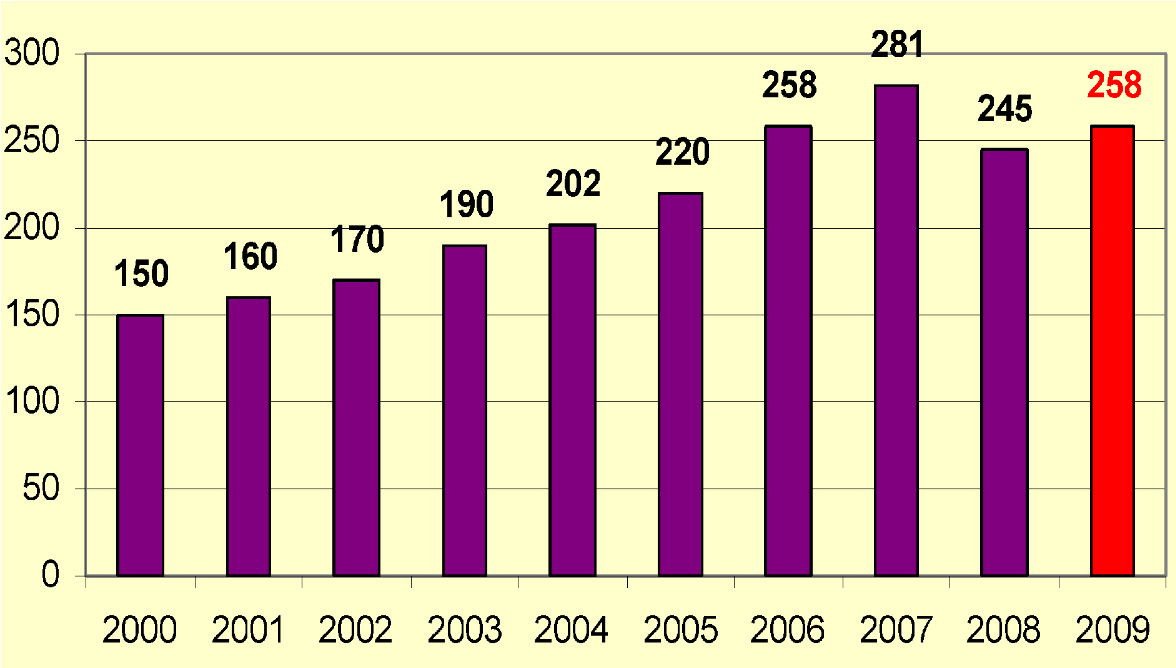


Figure (2.2) Accidents Cost Trends in Jordan During Period (2000-2009), **Ref: (3)**

The cost figures show a consistent increasing trend which is substantially high and represent about 2% of GDP of the country.

2.4.4 International Comparison

Numerous work was carried out on RTA cost in the various countries of the world especially the developed ones. However, care should be taken to ensure that both the definition and cost components used are identical when comparing values in different countries.

A World Bank Study estimates that about 720,000 people die annually worldwide in RTA and is likely increase to about 1.2 million in 2020 (37). The same study also estimated that worldwide only 50% of road injuries are reported, and there are about 100 injuries for each traffic fatality.

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According to the World Health Organization (WHO), an estimated 1.26 million humans lost their lives in 2000 as a result of RTA, making it the single leading cause of injury deaths worldwide (38). Estimates of RTA costs in India were given by Mohan (39) totaled more than 2% of GDP, similar to OECD countries.

Based on previous studies, Elvik (40) estimated RTA costs (excluding non-market impacts of pain and suffering) measured as a percentage of gross national product (GDP) for twelve countries. The estimates were found to range between 0.3 – 2.8% and to average 1.3% of GDP. Figure 2.3 shows the results.

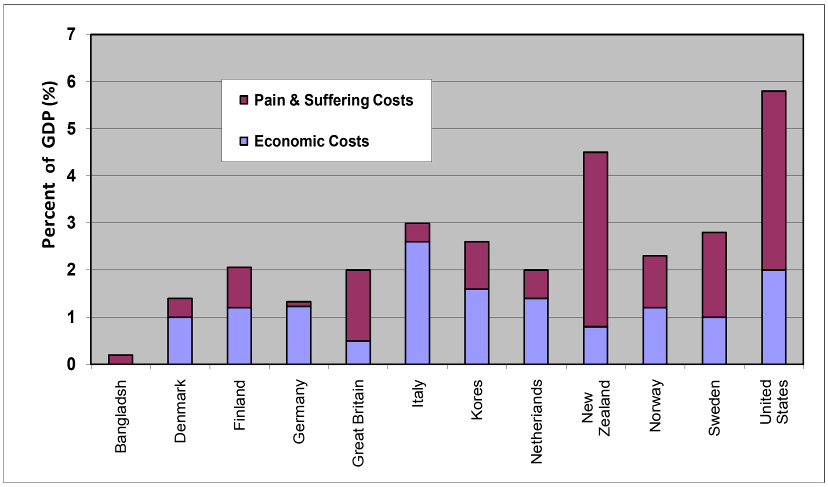


Figure (2.3) Accident Costs as Portion of GDP**, Ref. (37)**

A Review of various countries' RTA injuries death monetized cost values were carried out by the International Road Assessment (41). The results are summarized in Table 2.10 concluding that a default value of a statistical life (VSL) is 70 times average national GDP with a 60 to 80 range for sensitivity analysis.

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Table (2.10) Value of Statical Life (VSL) in 2004 Dollars

Country	Value Statistical Life	GDP / Capita	Method
Australia	$1,304,135	$28,935	HC
Austria	$3,094,074	$35,871	WTP
Bangladesh	$71,066	$1,710	HC
Canada	$1,427,413	$29,851	HC
France	$1,252,083	$29,472	HC
Germany	$1,257,451	$28,953	HC
Iceland	$3,303,555	$44,679	HC+PGS
India	$147,403	$2,651	WTP
Indonesia	$92,433	$3,125	HC
Latvia	$1,042,743	$18,140	HC
Lithuania	$746,531	$12,027	EC
Malaysia	$722,022	$9,513	WTP
Myanmar	$51,245	$1,545	HC
Netherlands	$1,944,026	$31,009	HC+PGS
New Zealand	$2,033,333	$25,024	WTP
Poland	$573,806	$14,984	HC
Singapore	$924,240	$25,034	HC
Sweden	$2,015,680	$32,394	WTP
Thailand	$222,056	$6,958	HC
UK	$2,292,157	$32,555	WTP
USA	$3,000,000	$36,311	WTP
Vietnam	$53,063	$2,475	HC

Source: Ref. (41)

HC = Capital Human

WTP = Willingness-to-Pay

PGS = Pain-Grief-Suffering

VSI = Value of Serious Injury

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CHAPTER THREE

AN OVERVIEW OF ROAD ACCIDENTS IN JORDAN

3.1 Introduction

The magnitude and the nature of the road safety problem vary between countries as well as the different road and street environment within a country. A description of the road safety situation in a country should include the following parameters (42):

1. Number of accidents, fatalities, and injuries: relative to the size of the population and vehicle fleet.
2. Measure of risk which is defined as the number of negative events (accidents and causalities) divided by the same relevant measure of risk exposure such as vehicle kilometer of travel.
3. Cost of accidents which is a measure of the amount of resources wasted in a country due to accidents.
4. Statistics in (1), (2), and (3) above classified by: road user categories, vehicle type, months in the year, days of the week, hours of the day, road and weather conditions, road and street environments, etc.

The lack of reliable data is a serious problem in most developing countries including Jordan where the rate of motorization in 2009 has reached a level of about 166Veh/1000 inhabitants and traffic accidents are emerging as a major cause of deaths and injuries.

Based on the available statistics, the road safety situation in Jordan is analyzed in the following sections.

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3.2 Accident Trends and Related Issues

3.2.1 Background

Jordan has a total area of 89 sq. Km and an estimated population of about 6 million in 2009 reaching a population density of 67.4 person/ Km^2. The average annual growth rate of population was 2.6% between 1994 and 2004 then decreased to 2.2% between 2004 and 2009. According to the latest estimates of 2009, 51.5% of population is male and 48.5% is female (43). The country is administratively divided into 12 governorates with their estimated resident population in 2009 as shown in Table 3.1.

Table (3.1) Population of Jordanian Governorates (2009)

No.	Governorate	Population
1	Amman	2,027,685
2	Irbid	950,695
3	Zarqa	838,250
4	Balka	349,580
5	Karak	214,225
6	Mafraq	245,665
7	Maan	103,915
8	Aqaba	107,115
9	Madaba	135,890
10	Tafyla	81,000
11	Jarash	156,675
12	Ajloan	118,305

Source: Ref. (43)

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3.2.2 Location, Climate and the Economy

Jordan is located in the heart of the Middle East, Northwest of Saudi Arabia, South of Syria, Southwest of Iraq, and East of the Palestinian National Authority. Jordan has access to the Red Sea via the port city of Aqaba, located at the northern end of the Gulf of Aqaba.

The climate of Jordan is that of the East Mediterranean type, which is characterized by being hot and dry in summer, cold and humid in winter where temperatures drop below zero in certain highlands.

The highest amount of rainfall in 2009 was of 568.0 mm recorded at Ras Moneef and the lowest of 1.4 mm in Aqaba.

The Gross Domestic Product (GDP) of Jordan was estimated to be about JD 14.5 billion (US $20.4billion) in 2008, whereas the estimated Gross National Product (GNP) was about JD 16.6 billion (US $23.4billion). The GDP figure is equivalent to JD 2754 per capita (US $3879). The growth rate of GDP in the year 2007/2008 at constant market prices was 7.6%.The distribution of GDP by economic activity at current basic prices for the year 2008 is given in Table 3.2.

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Table (3.2) GDP by Economic Activity at Current 2008 Prices

Economic Activity	JD million	**(%) of Total**
A. Industries		
1. Agriculture, Hunting and Fishing	373.6	2.5
2. Mining and Quarrying	843.0	5.8
3. Manufacturing	2933	20.2
4. Electricity and Water	254.2	1.75
5. Construction	697.9	4.8
6. Wholesale & Retail Trade, Restaurants & Hotels	1503.2	10.4
6-1 Wholesale and Retail Trade	1256.9	8.6
6-2 Restrants and Hotels	246.3	1.7
7. Transport, Storage & Communication	1848.2	12.7
8. Finance, Insurance, RealEstate & Business Services	2639.2	18.2
8-1 Finance, Insurance Services	1423.3	9.8
8-2 Real Estate	1215.9	8.4
9. Community, Social and Personal Services	584.6	4.0
Total	11676.9	
B. Producers of Government Services	3427.0	
C. Producers of Private non-Profit Services to Households	82.2	
D. Domestic Services of Households	49.5	
Total (A+B+C+D+)	15235.5	
- Imputed Bank Service Charge	-749.7	
- Gross Domestic Product At Basic Prices	14485.8	
- Net Taxes On Products	1622.2	
- Gross Domestic Product At Market Prices	16108.0	

Source: Ref. (43)

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3.2.3 Vehicle Ownership and Composition

The rising income of the people in Jordan added to the inferior public transport systems encourage private vehicle ownership. Table 3.3 shows the growth in vehicle ownership in Jordan over the past ten years for the period 2000-2009. In 2009, vehicle ownership expressed as vehicle per 1000 population was about 166.

Table (3.3) Growth in Vehicle Ownership in Jordan During the Period (2000-2009)

Year	Registered Vehicles
2000	473,339
2001	509,832
2002	535,112
2003	568,096
2004	614,614
2005	679,731
2006	755,477
2007	841,933
2008	905,592
2009	994,753

Source: Ref. (3)

The vehicle composition shown in Table 3.4 highlights the high proportion of passenger cars at 68.3%, trucks proportion 12.9% and buses 2.1% of the total number of registered vehicles. During the last ten years, the annual growth rate of the number of vehicles fluctuated between as low as 4.38% in 2003 and as high as 9.37% in 2002 with an annual average of 8.6%.

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Table (3.4) Vehicle Types in 2009

Vehicle Types	No.	(%) of Total
Motorcycle	4,904	0.5
Passenger Car	681,821	68.3
Mini Bus	16,686	1.8
Bus	3,300	0.3
Trucks	128,702	12.9
Agricultural Vehicle	9,198	0.9
Construction Vehicle	1,081	0.1
Dual Purpose Vehicle	93,905	9.4
Special Purpose Vehicle	3,641	0.4
Trailer	461	0.05
Semi-trailer	20,715	2.1
Tractor	19,290	1.9
Articular Track	1,329	1.35
TOTAL	**994,753**	**100**

Source: Ref. (3)

3.2.4 Accident Rates and Trends

Since the seventies Jordan started witnessing a modern development and so the traffic issue. This development led to the increase in vehicle ownership during recent years. Annual statistics of traffic accidents show that their number was 11,113 in 1979, with 354 killed. By 1998, the number of accidents had increased to 43,343, with 612 killed, although the size of vehicle fleet was only 365,196. In 2009, the corresponding figures increased to 122,793 accidents with 676 fatalities and 994,753 vehicles. Figure 3.1 shows the changing pattern of these parameters between 1979 and 2009.

Annual statistics for population, number of vehicles and road traffic accidents, during the period between 2000 and 2009 were used to show the changing pattern in fatalities, injuries, accidents and accident rates as shown in Table 3.5

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Table (3.5) Annual Statistics for Road Traffic Accidents

year	No. of vehicles	Inhabitants ×1000	traffic accidents	injuries	fatalities	Acc./10,000 Veh.	Acc. /10,000 inhabitant
2000	473339	5039.0	52796	18842	686	1115.4	10.5
2001	509832	5182.0	52662	18832	783	1032.9	10.2
2002	535112	5329.0	52913	17381	758	974.8	9.9
2003	568096	5480.0	62115	18368	832	1086.9	11.3
2004	614614	5350.0	70266	16727	818	1147.5	13.1
2005	679731	5473.0	83129	17579	790	1223.0	15.2
2006	755477	5600.0	98055	18019	899	1279.9	17.5
2007	841933	5723.0	110630	17969	992	1314.0	19.3
2008	905592	5850.0	101066	13913	740	1116.0	17.3
2009	994753	5980.0	122793	15662	676	1234.4	22.2

Source: Ref. (3)

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The increase in registered vehicles, without significant change or development of the present traffic system (traffic control devices, marking, geometric design…etc), led to increase in traffic accidents and the resulting casualties.

There was a total of 52796 traffic accidents in year 2000 increasing to 122793 accidents in 2009, vehicles have doubled over the same period from 473339 to 994753.

The history of road traffic accident rates in Jordan between 2000 and 2009 is also shown in Table 3.5, where accidents are related to population and vehicles only. No data is available on distances traveled and therefore this rate is not used. It can be seen that accident rate per 10,000 registered vehicles tends to decrease with time during the period 2000- 2004 but has increased since 2004. On the other hand, accident rate per 10,000 inhabitants shows a continual increase. In fact the latter rate has more than doubled during the same period.

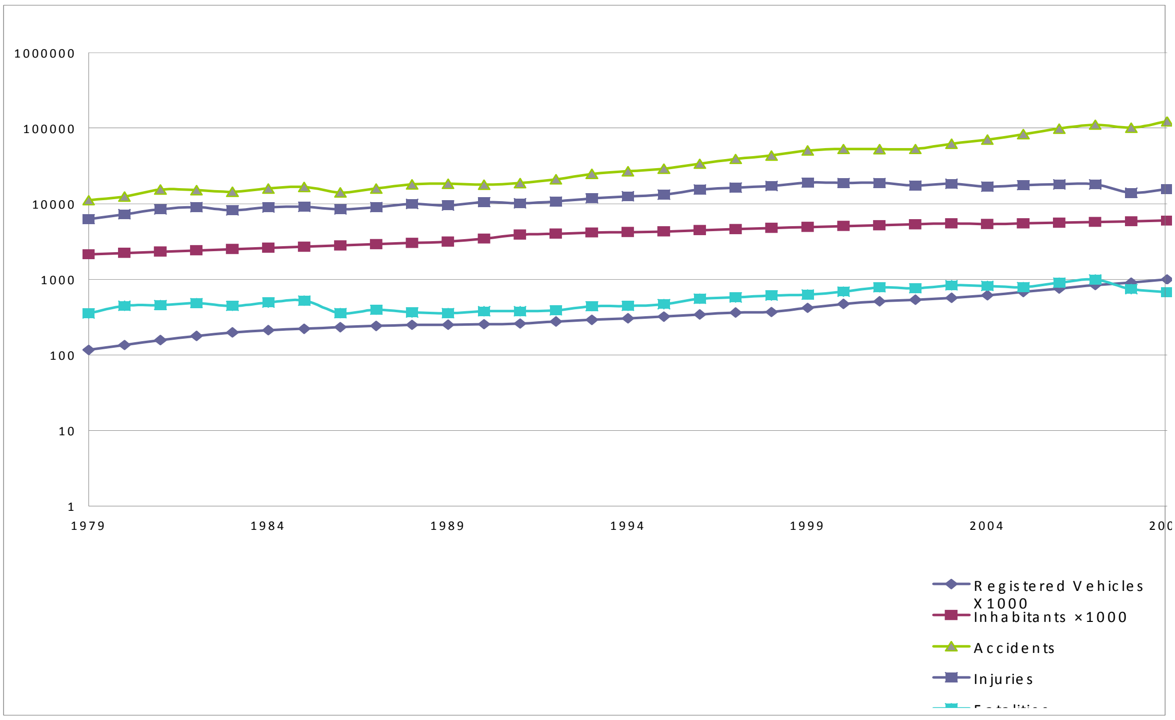


Figure (3.1) Trends of population, Registered Vehicles and Accident Statistics, **Ref. (3)**

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3.2.5 Fatality and Injury Rates

Three parameters, total number of fatalities, fatality rate per population and fatality rate per distance traveled, are considered particularly significant for comparative purposes and economic of projects. The other two parameters, fatality rate per vehicle and fatality index are commonly used to identify the seriousness of the road accident situation in one particular country. The number of fatalities and injuries in relation to the number of registered vehicles, population and number of accidents in Jordan during the period 2000-2009 are shown Table 3.6. It can be seen that the number of casualties (fatalities + injuries) per 10,000 vehicles has fell in general but fluctuated when related to population. This could be correlated to the trend of annual growth of both parameters.

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Table (3.6) Trends of Traffic Accidents Related Statistics During the Period (2000- 2009).

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Accidents	52796	52662	52913	62115	70266	83129	98055	110630	101066	122793
Fatalities	686	783	758	832	818	790	899	992	740	676
Injuries	18842	18832	17381	18368	16727	17579	18019	17969	13913	15662
Fatalities / 1000 accidents	12.9	14.8	14.3	13,4	11.6	9.5	9.168.9	8.9	7.3	5.5
Injuries / 1000 accidents	356.8	357.6	328.5	295.7	238	211.5	183.7	162.4	137.7	127.5
Fatality Index*	0.035	0.039	0.04	0.043	0.046	0.043	0.047	0.052	0.05	0.041
Fatality per 10.000Vehicles	14.5	15.4	14.0	14.6	13.4	11.6	11.9	11.8	8.2	6.8
Injury per 10.000Vehicle	398.1	369.4	320.2	321.4	373.2	258.6	238.5	213.4	153.6	157.4
Fatality /100.000 Populations.	13.6	15.1	14.2	15.2	15.3	14.4	16.1	17.3	12.6	11.3
Injury /100.000 Populations.	373.9	363.4	326.2	335.2	312.6	321.2	321.8	314.0	237.8	261.9
Severity Rate**	0.37	0.37	0.34	0.31	0.25	0.22	0.19	0.17	0.14	0.13

Source: Ref. (3)

* Fatality Index = No. of fatalities / No. of casualties

** Severity Rate = No. of casualties / No. of accidents

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The percentage of fatalities to total casualties in Jordan is considered high and was particularly highest in 2007 and 2008 (5.2% and 5.0% respectively). Table 3.6 show that the number of injury accident has decreased recently with higher fatality index which could be related to under-reporting of slight injury accidents.

Figure 3.2 also shows that accident severity rates declined during the period (2000 - 2009). This reflects the positive impact of government efforts to improve road safety, including new regulations, enhanced geometric road design, and public awareness campaign through the Jordanian Traffic Institute, and other concerned parties.

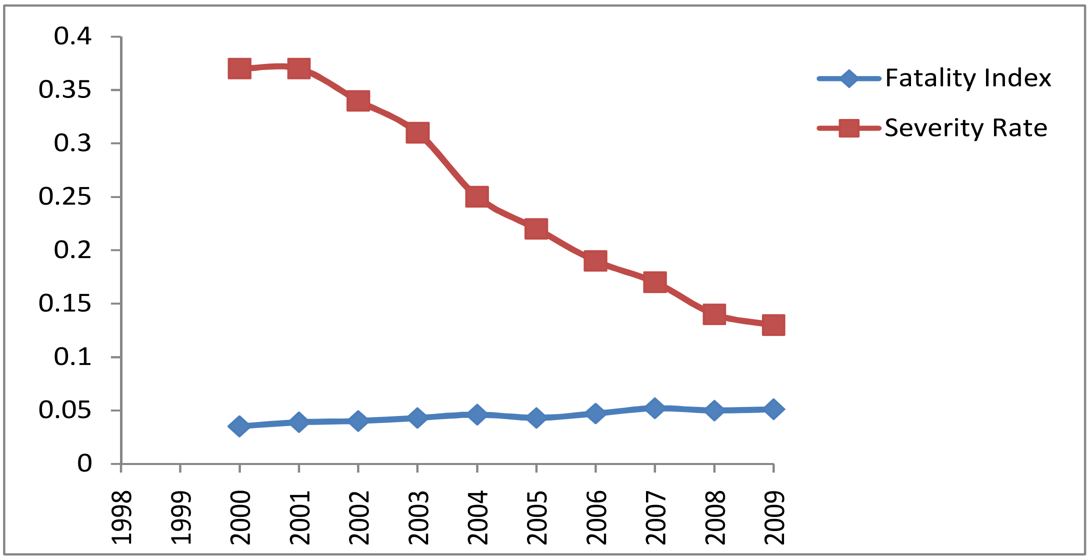


Figure (3.2) Severity Rates and Fatality Indices for Year 2000 to 2009**, Ref. (3)**

The current fatal to injury ratio is about 1:20 which compares well with the Middle East and North Africa where it is 1:12. However, the ratio compares poorly with developed countries such as the United Kingdom for example where the figure is around 1:80.

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3.2.6 Comparison between Jordan and Other Countries

The most relevant risk measures are the number of accidents per veh-km or the number of fatalities and injuries per person-km. Unfortunately, data on vehicle kilometers and person kilometers are not available in Jordan and many other developing countries, thus the number of vehicles and population are the measure of risk exposure that are used here.

For better understanding of road traffic accidents in Jordan, it is necessary to compare statistical data with other developed or developing countries. Table 3.7 and Figures 3.3 and 3.4 show recent statistical data on accidents, injuries and fatalities in a number of Arab countries which share similar culture as Jordan. It can be seen that Jordan compares favorably with Arab countries regarding the fatality rate per 100,000 persons but not so well regarding the fatality rate per 10,000 vehicles. However, both Jordanian fatality rates fall much behind when compared with developed countries such as UK, Sweden, Japan, Netherlands and Switzerland.

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Table (3.7) International Comparison of Fatality Rates (2008)

State	fatalities per billion veh- km	fatalities per 10,000 motor vehicles	fatalities per 100,000 pop
Australia	6.51	0.96	6.8
Austria	*	1.16	8.15
Belgium	*	1.68	10.08
Canada	*	1.12	7.18
Denmark	8.22	1.4	7.37
Finland	*	1.1	6.49
France	8.12	1.1	6.91
Germany	6.49	0.8	5.45
Greece	*	*	14.43
Hungary	*	2.7	9.92
Japan	6.6	0.66	4.72
Korea	*	2.9	12.72
Malaysia	*	3.7	23.5
Netherlands	*	0.75	4.13
New Zealand	9.13	1.1	8.57
Norway	*	0.8	5.38
Sweden	7.6	0.7	4.32
Switzerland	5.59	0.7	4.7
U.K	5.2	0.8	4.31
United States	8.0	7.91	12.25
Saudi Arabia	*	97.13	26.64
Kuwait	*	3.03	11.91
Lebanon	*	3.17	9.56
Bahrain	*	2.09	8.02
Sudan	*	256.1	6.37
Jordan	*	**8.17**	**12.65**

*** Information is not available**

Source: - Police Department, Arab International / Jordan Interpol office

- International Road Traffic Accidents Data (IRATD) / Paris

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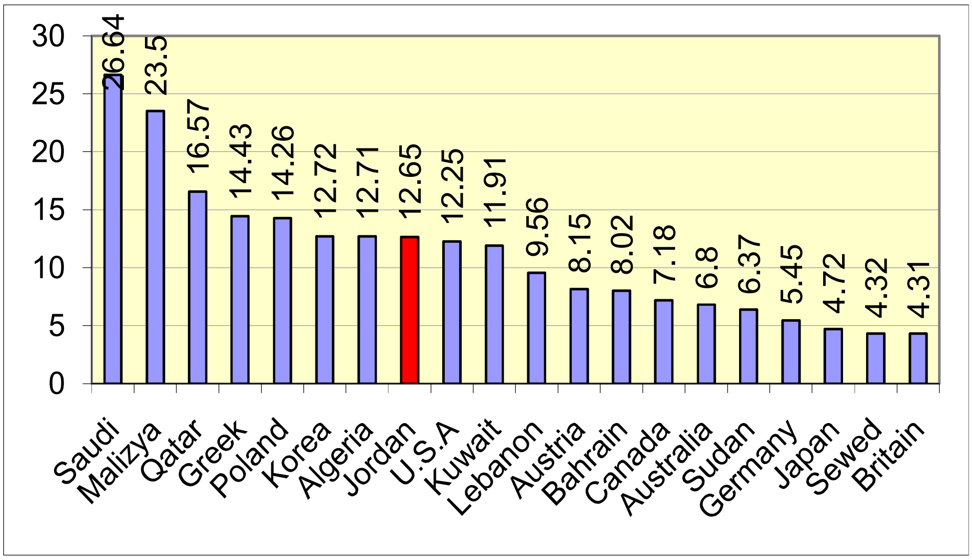


Figure (3.3) fatality / 100,000 inhabitants in selected countries for the year 2008

Source: - Police Department, Arab International / Jordan Interpol office

- International Road Traffic Accidents Data(IRATD)/ PARIS

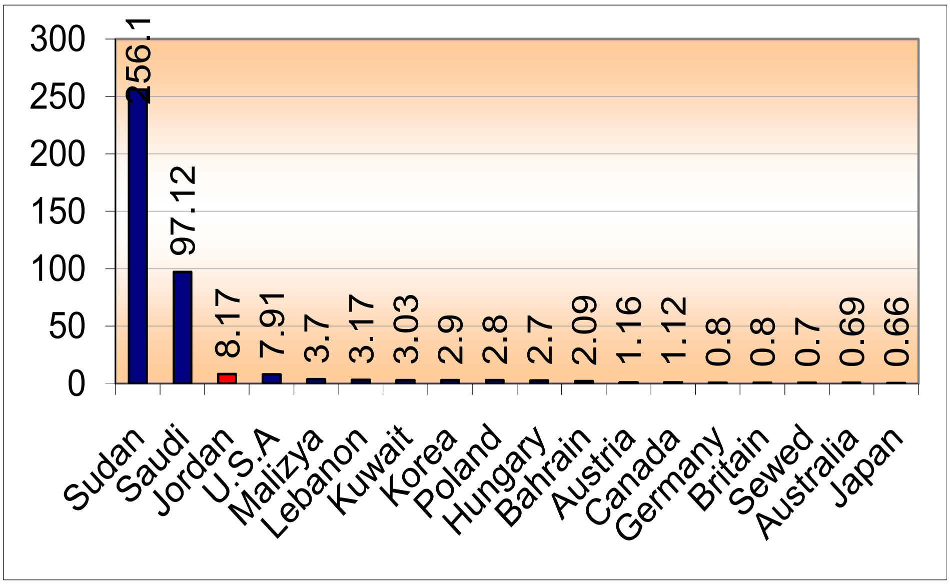


Figure (3.4) fatality / 10,000 Vehicles in selected countries for the year 2008

Source: - Police Department, Arab International / Jordan Interpol office

- International Road Traffic Accidents Data(IRATD)/ PARIS

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The total number of accidents, injuries and fatalities in relation to population are normally lower in the developing countries than in the developed world. The reason for the lower figure in the developing world is the relatively small number of motor vehicles per inhabitant. However, it should be noted that the figures are influenced by factors other than culture such as car ownership and the definition of a fatality. The latter factor in Kuwait, for example, is for persons dying within 30 days of an accident and in Saudi Arabia it counts only those killed at the accident scene while in Jordan it counts those killed within one month of occurrence of accident.

3.3 Accident Data Analysis for the Year 2009

3.3.1 Introduction

Analyses of road accident patterns are essential in order to understand the nature of the problem and to choose proper countermeasures. The analyses of road accidents generally relate to conditions in the country and the recommended countermeasures relate to these conditions. This section presents a detailed analysis of traffic accidents that occurred in 2009 in Jordan in order to derive some accident characteristics and assists in devising some potential countermeasures. The results presented are those of the analysis of data obtained from Jordan Traffic Institute.

3.3.2 Location

Table 3.8 shows the distribution of accidents by region. It can be seen that there are more accidents in the more urbanized regions such as Amman, Zarqa, and Irbid. This may be explained by:

a. under- reporting of accidents in rural areas.

b. higher accident risks in urban areas; and

c. a large proportion of motor vehicles are based and driven in the urban areas.

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Table (3.8) Traffic Accidents by Region

Region	No. of accidents	(%) of Total
Amman	84367	68.7
Irbid	10059	8.20
Zarqa	10829	8.80
Balka	4819	3.90
Karak	1710	1.40
Mafraq	2078	1.70
Maan	1096	0.89
Aqaba	2562	2.0
Madaba	1463	1.20
Tafyla	845	0.68
Jarash	1606	1.30
Ajloan	1359	1.23
TOTAL	**122793**	**100**

The exact locations of accidents require a detailed investigation of police accident reports. However, even those reports lack exact accident location data which is either imprecise or recorded inaccurately or incompletely.

3.3.3 Temporal Variation

There are three cyclic variations of road traffic accidents with time. These are the variations of accidents by hour of day, day of a week and month of the year which are discussed in the following paragraphs.

The distribution of accidents by hour of day is shown in Table 3.9. It can be seen that highest percentage of accidents (11.5%) occurs during the afternoon peak hour (2-3 p.m) when people leave work to home thereby generating high traffic volumes. As expected, late night hours (2-5 am) exhibit the lowest percentage of accidents (an

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average of 0.45% each hour) because this period corresponds to the same period of low traffic volumes.

Table (3.9) Distribution of Traffic Accidents by Hour of Day

Hour	No. of accidents	(%) of Total
00:00 - 00:59	1301	1.06
01:00 - 01:59	1469	1.19
02:00 - 02:59	1093	0.89
03:00 - 03:59	621	0.51
04:00 - 04:59	576	0.47
05:00 - 05:59	508	0.41
06:00 - 06:59	827	0.67
07:00 - 07:59	2937	2.39
08:00 - 08:59	4634	3.77
09:00 - 09:59	4445	3.62
10:00 - 10:59	5915	4.82
11:00 - 11:59	8001	6.52
12:00 - 12:59	9716	7.91
13:00 - 13:59	8743	7.12
14:00 - 14:59	14130	11.5
15:00 - 15:59	10891	8.87
16:00 - 16:59	9149	7.45
17:00 - 17:59	7669	6.25
18:00 - 18:59	8716	7.09
19:00 - 19:59	6371	5.12
20:00 - 20:59	4425	3.60
21:00 - 21:59	4913	4.0
22:00 - 22:59	3191	2.59
23:00 - 23:59	2552	2.18
Total	**122793**	**100**

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The number of traffic accidents also varies by day of week as shown in Table 3.10. Most accidents occur during Thursday (16.6% of the total weekly accidents), which is the last working day of the week. The lowest percentage of accidents (9.5%) occurs on Friday which is a weekend day followed by Saturday (13.9%) which is the second weekend day. The five working days (Sunday-Thursday) show similar magnitudes averaging of about 15% each. These results agree with the trends of traffic volumes along the various links of the urban road network.

Table (3.10) Distribution of Traffic Accidents by Day of Week

Weekday	No. of accidents	(%) of Total
Saturday	17042	13.9
Sunday	18691	15.2
Monday	18537	15.1
Tuesday	18543	15.1
Wednesday	17923	14.6
Thursday	20367	16.6
Friday	11690	9.50
Total	**122793**	**100**

Table 3.11 shows the monthly distribution of traffic accidents. It can be seen that the summer months of July, August and September have the highest number and percentages of accidents. The corresponding respective percentages are 9.6, 9.6 and 9.5%. This may be explained by the increase in both vehicles and tourists during these months because of summer time and coming back of Jordanians expatriates from different countries especially the Gulf to spend their summer holidays with their families.

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Table (3.11) Distribution of Traffic Accidents by Month

Month	No. of accidents	(%) of Total
Jan.	**8456**	6.9
Feb.	**8595**	7.0
Mar.	**9361**	7.6
Apr.	**9479**	7.7
May	**10285**	8.4
Jun.	**10403**	8.5
Jul.	**11731**	9.6
Aug.	**11807**	9.6
Sep.	**11667**	9.5
Oct.	**10791**	8.8
Nov.	**9530**	7.7
Dec.	**10688**	8.7
TOTAL	**122793**	**100**

3.3.4 Vehicles Involved

Accidents were categorized according to the type of vehicles involved as shown in Table 3.12. It can be seen that out of the 239,822 vehicles involved in accidents, 68.4 % were passenger cars. This may indicate the effect of the relatively high prevalence of passenger cars in Jordan and the tendency of their drivers for speeding.

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Table (3.12) Distribution of Vehicles Involved In Traffic Accidents by Vehicle Type

Type of vehicle	No. of vehicles involved in accidents	(%) of Total
Passenger Car	**164044**	68.4
Bus	**18696**	7.8
Truck	**48341**	20.2
Other	**8741**	3.6
TOTAL	**239822**	**100**

3.3.5 Casualty Profile

The fatalities and injuries were distributed based on severity. Figure 3.5 shows that slight injuries constitute 86% of total causalities. However, the relatively high percentage of serious injuries of 10% and 4% involving deaths cause much of concern.

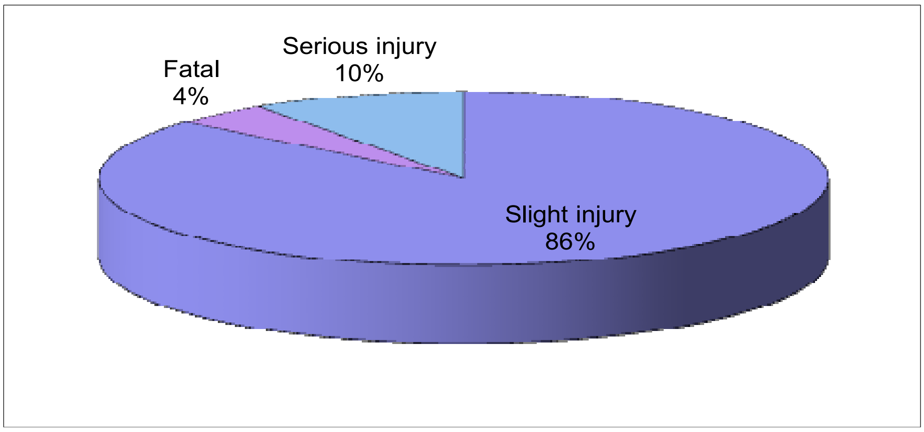


Figure (3.5) Distribution of Causalities by Severity, **Ref. (3)**

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Concerning gender, females were involved in a lower percentage of causalities (21%) indicating more use of roads by males. In addition, it is generally noticed that females are more abiding to traffic regulations including the use of safety belts, thereby reducing their severity of injury.

As regards to age group, most casualties were young to middle aged. The distribution of casualties by age group is shown in figure 3.6 which reveals that around 62.8% of causalities were between 15 and 45 years old. This may be attributed to the fact that this group tend to use roads more frequently.

The distribution of causalities by gender and age group is given in Table 3.13.

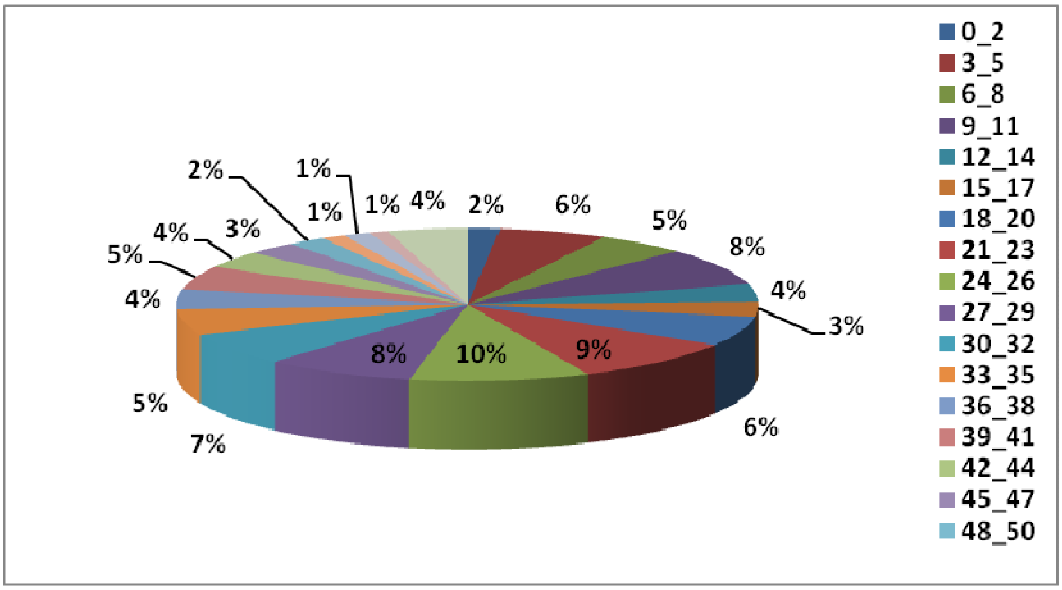


Figure (3.6) Causalities by Age Group, **Ref. (3)**

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Table (3.13) Causalities by Age Group & Gender

Age Group	Fatality		Slight Injury		Sever Injury	
	Male	Female	Male	Female	Male	Female
0 – 2	14	13	138	92	28	10
3 – 5	33	18	566	254	73	32
6 – 8	18	10	493	211	54	28
9 – 11	42	8	881	176	179	23
12 – 14	12	1	392	133	42	15
15 – 17	15	3	325	134	41	3
18 – 20	31	8	739	177	74	12
21 – 23	41	5	1096	252	114	15
24 – 26	56	5	1149	271	120	22
27 – 29	35	8	999	206	91	17
30 – 32	34	7	820	170	92	14
33 – 35	29	5	618	162	68	15
36 – 38	22	0	511	104	48	8
39 – 41	32	5	574	134	63	6
42 – 44	21	0	392	124	42	10
45 – 47	25	2	291	81	37	10
48 – 50	17	4	210	91	22	8
51 – 53	6	5	155	31	14	1
54 – 56	12	5	146	60	20	2
57 – 59	7	2	108	41	12	5
+ 60	50	10	443	155	48	18
Total	**552**	**124**	**11046**	**3060**	**1282**	**274**

Figure 3.7 shows the distribution of casualties based on road user type. It may be seen that car drivers represent the highest percentage of casualties of about 39.75% followed by passenger casualties with 35%. It is noticed that pedestrians represent 26.25% of total casualties. This may be partly explained by the lack of pedestrian facilities and poor driver behavior which discourages pedestrians from walking or crossing streets.

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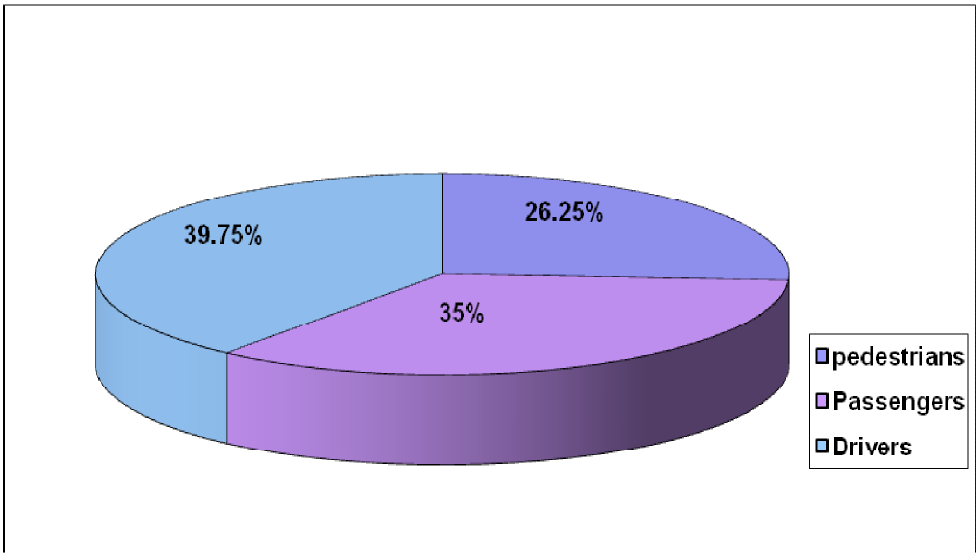


Figure (3.7) Causalities by Road User Type, **Ref. (3)**

3.3.6 Accident Type

The statistical data provided categorize accidents into three types namely collision, pedestrians and turnover. Table 3.14 shows the distribution of accidents by type. It can be seen that pedestrian accidents account for 3.4%, collision accidents 95% and turnover accidents 1.4% of the total number of accidents. Although pedestrian accidents represent low percent of total accidents, they exhibit the highest causality and severity rates. This may be due to the fact that each motor vehicle interacts with high pedestrians per Kilometer driven. In addition inappropriate behavior both on the part of drivers and pedestrians and poor visibility due to the lack of street lighting and non- functioning vehicle lights may also contribute to these results. Research showed that pedestrian severity increases with the square of vehicle impact speed (44).

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Table (3.14) Accidents by Type

Accident Type	Property Damage	Injuries	Fatalities	Total	Percent (%)
Collision	111974	4881	264	117119	95.2
Pedestrian	0	3833	221	4054	3.40
Turn Over	585	926	109	1620	1.40
Total	**112559**	**9640**	**594**	**122793**	**100.0**

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CHAPTER FOUR

EVALUATION OF ACCIDENT COSTS

4.1 Introduction

Despite the difficulty of attributing monetary values on the losses arising from traffic accidents, estimates of accident costs are essential for the evaluation of different road safety programs and to satisfactory decision-making in road safety.

Different approaches to evaluate accident costs have been used generating substantially different costs. The alternative approaches, however, may be broadly classified into macroscopic and microscopic. The first employer various aggregates and average to build up estimates and derives only broad magnitudes. The second, however, requires a detailed study of all accidents within a selected area; it is therefore costly but has become more common (45).

4.2 Accidents Cost Categories

Accident costs can be divided into:

1. Internal costs, which are damages and risks to the individual traveling by a particular vehicle.
2. External costs, which are uncompensated damages and risks imposed by an individual on other people, and.
3. Insurance costs, which are damages compensated by insurance. These are external at the individual level but internal to premium payers as a group.

The distribution of various accident costs are indicated in Table 4.1. It should be noted that when non-market costs such as lost quality of life, pain or grief are compensated by

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insurance or litigation, they become market costs. Market costs involve goods that are traded in a competitive market, such as vehicles, land and fuel. Nonmarket **costs** involve goods that are regularly traded in markets such as clean air, accident risk, and quiet.

Table (4.1) Various Accident Cost Categories

Category	**Market**	**Non-Market**
A. Internal	**1.** users: **a.** property damage **b.** lost income **c.** medical treatment **2.** safety equipment Expenditure	Victims: **a.** pain and suffering **b.** lost quality of life
B. External	**1.** Non- users: **a.** property damage **b.** lost income **c.** medical treatment **2.** Emergency response services **3.** Accident prevention expenditure	**1.** Non- users: a. pain and suffering b. lost quality of life **2.** Grief to victims family and friends 3. Reduced non-motorized
C. Insurance	Any of the above which are compensated by insurance	Any of the above which are compensated by insurance

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Accident externalities contribute substantially to accident costs. Elvik (46) after defining three types of accident externalities namely system, physical injury and traffic volume concluded that 37-44% of accident costs in Norway are external.

4.3 Accident Cost Analysis

Accident cost analysis involves two steps:

1. Quantify physical impacts, such as the number of accidents that occur, the number and severity of vehicle damages, human causalities (injuries and fatalities).
2. Measure in monetary values of market and non-market costs of the above mentioned impacts.

Two general perspectives are used in accident cost studies, reflecting the scope of impacts that are considered:

1. The human Capital method which measures only market costs, including property damage, medical treatment and lost productivity. In other words, the method only considers financial costs.
2. The comprehensive approach which adds non-market costs including pain, grief and reduced quality of life, as reflected by people's willingness-to-pay for increased safety, or willingness-to-accept increased accident risk and damages.

The difference between the two willingnesses reflects the allocation of ″rights″ as the first (pay), in contrast to the second (accept), considers road user to have no inherent right to safety. Therefore, the willingness-to- accept is used for compensation analysis as legal and economic practices assume that individuals have a fundamental right to safety from damages caused by other people's actions.

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A comparison between the two estimates of accident costs is given in Figure 4.1.

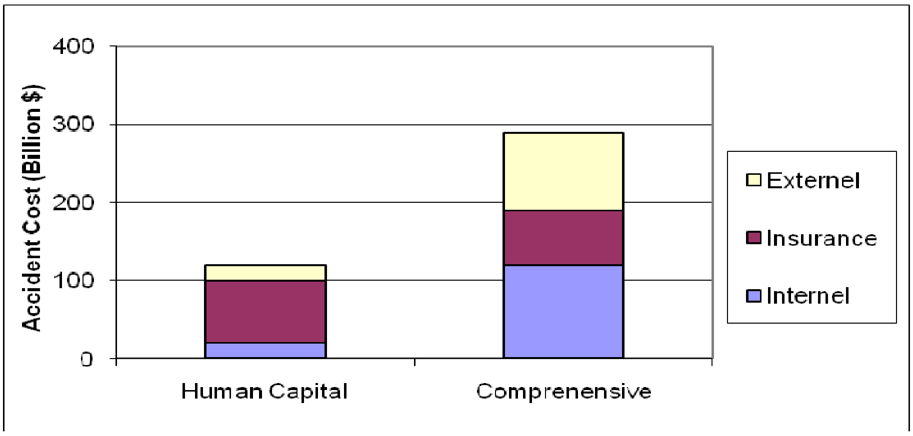


Figure (4.1) A Comparison between Willingness-To-Pay & Willingness- To- Accept approaches

4.4 A Framework for Costing Accidents

The alternative approaches of accident costing generate substantially different values as they differ in the included cost elements and classes of accidents and the reliability of the sources of information. Therefore, it is essential for a successful accident cost study to prepare a framework outliving the evaluation method used, the classes of accidents and the cost elements considered, in addition to specifying the source of information and the unit cost used for estimation.

The following section presents details for the method used and results obtained from the process of evaluating accident costs in Jordan.

4.4.1 Data Collection

Various sources of information were used to collect the required data. The main source was the Jordanian Traffic Institute (3). As stated in section 4.3, the first step in accident cost analysis involves quantifying the physical impacts of accidents. Table 4.2 gives accident statistics for the year 2009 which will be subjected to a detailed analysis in order to estimate their costs.

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Table (4.2) Accidents for the Year 2009

Accident Severity	Number of Accidents	Number of Fatalities	Number of Serious Injuries	Number of Slight Injuries	Total Number of Casualties*	Number of Involved Vehicles
Fatal Accident	594	676	311	892	1879	933
Injury Accident	9640	-	1245	13214	14459	15399
Property Damage Accident **(PDO)**	112559	-	-	-	-	214749
TOTAL	**122793**	**676**	**1556**	**14106**	**16338**	**231081**

Source: Ref (3)

* Casualties = Sum of injuries & fatalities

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4.4.2 Cost Evaluation Methods and Cost Elements

Various approaches to evaluate accident costs have been used which generated substantially different costs. These approaches may be broadly classified into macroscopic and microscopic. The first employes various aggregates and averages to build up estimates and derive only broad magnitudes. The second, however, requires a detailed study of all accidents within a selected area and is therefore costly. The choice of the method to be used is conditioned by the availability of suitable and reliable data.

Six methods or approaches to estimate traffic accident costs are identified:

1. Gross output
2. Net output
3. Life- insurance
4. Count award
5. Implicit public sector valuation
6. Willingness-to-pay

The appropriate method depends on the objectives being pursued in particular countries. However, the gross output approach has been recommended and used in developing countries and will be used in this research.

Gross output is appropriate for maximizing the wealth of a country; the cost is the sum of the following:

1. The loss of the value of the output.
2. Cost of medical treatment.
3. Cost of vehicle and property damage.
4. Cost of police and insurance administration.
5. The cost in terms of human pain, grief and suffering.

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The different approaches to accident costing recognize the following elements of cost as being the most important (45):

a) Loss of output due to fatality or injury.

b) Property damage costs.

c) Medical costs.

d) Insurance costs (compensation, claims).

e) Incidental costs (legal, administration, traffic delay, etc.)

f) Cost of research and promotion of road safety.

g) Intangibles such as suffering and social disruption (subjective elements).

In the following investigation of the 2009 total accidents cost in Jordan only those costs that can be ascertained by estimation or calculation will be considered .These are:

1. Victim Related Cost:

a - Loss of Output (due to fatalities and Injuries)

b - Medical Cost

c - Pain and Suffering

2. Property Damage:

a - Vehicle Damage Repair

b - Detention Period for the Repair of Damaged Vehicles

3. Administration Cost:

a - Police Investigation or related activities

b - Insurance Administration

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4.4.3 Unit Cost, Classes of Accidents and Analysis Framework

There are several unit costs that can be used to estimate total accident costs. The choice between these alternatives depends upon the purpose of study, data availability and the prevailing types of accidents. This study will consider unit casualty cost, unit property damage cost, unit cost of insurance administration and the unit cost of police investigation as a basis for accident costs estimation.

The accident may be used as the unit cost with the purpose of estimating the total costs, while the estimation of specific unit costs uses the involvement, rather than the accident, as the unit cost.

The cost of an accident varies depending upon many factors including the class of accident, number and type of the involved vehicles, time and location of the accident. In order to take into account the major factors affecting accident costs, the framework of this study classifies accidents into the following severity levels:

1. Fatal accidents.
2. Injury accidents.
3. Property Damage Only accidents.

For ease of analysis it is assumed that all casualties are employed and are productive members of the society. Also it is assumed that their income is constant over their productive years, and that females have the same economic opportunity as males.

As recommended by Andreassend (47) the average cost of an accident for a certain severity level is computed as follows:

$$\mathbf{ACi} = \mathbf{R1}\,(UcD) + \mathbf{R2}\,(UcPs) + \mathbf{R3}\,(UcPm) + \mathbf{R4}\,(Uc\ PDO) + \mathbf{R5}\,(UcPAi) + \mathbf{R6}\,(UcIA) \qquad \textit{(4.1)}$$

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Where:

ACi = the average cost of an accident of severity level (i).

UcD = the unit average cost of fatality.

UcPs = the unit average cost of serious injury

UcPm = the unit average cost of slight injury

UcPDO = the unit average cost of property damage only.

UcPAi = the unit average cost of police investigation.

UcIA = the unit average cost of insurance administration.

The Coefficient Ratios (**R1 – R6)** represent the average number of involvements in a certain severity level:

- **R1**= Coefficient Ratio of number of fatalities to total number of fatal accidents
- **R**2= Coefficient Ratio of number of serious injures to the total number of fatal or injury accidents
- **R3**= Coefficient Ratio of number of slight injures to the total number of fatal or injury accidents
- **R4**= Coefficient Ratio of number vehicles involved in accident to the total number of fatalities or injures or PDO accidents
- **R5**= Coefficient of Police Investigation (1.0).
- **R6**= Coefficient o Insurance Administration (1.0).

The above framework forms the basis for calculating the estimated total cost of traffic accidents in Jordan.

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4.5 Accidents Cost Estimation

Based on the information in Table 4.2 the Coefficient Ratios R1 through R6 for fatal accidents can be calculated as follows:

R1 = 676/594 = 1.14

R2 = 311/594 = 0.52

R3 = 892/594 = 1.5

R4 = 933/594 = 1.57

R5 = 1.0

R6 = 1.o

Similar calculations were performed for all accident severity levels and the results are summarized in Table 4.3.

Table (4.3) Coefficient Ratios (**R1 – R6)**

Accident severity	**Coefficient ratio**					
	R1	**R2**	**R3**	**R4**	**R5**	**R6**
Fatal Accidents	1.14	0.52	1.50	1.57	1.0	1.0
Injury Accidents	-	0.13	1.37	1.6	1.0	1.0
PDO Accidents	-	-	-	1.9	1.0	1.0

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4.5.1 Victim Related Costs

The following section presents the various elements related to the victim and how these elements were estimated

4.5.1.1 Loss of Output Due to Fatalities

The value of lost output productive capacity is a major indirect cost item and contributes to a high proportion of accident costs. It represents the economic value of human life.

As stated in section 4.1, different approaches may be used to evaluate accident costs. Out of these, the gross output approach was adopted in this study to evaluate the human life for Jordan being the most suitable for the available data and successfully used in other several studies (45, 48, and 49). For the estimation of output losses due to fatalities, the following assumptions were adopted:

1. Unemployment rate is 12%.

2. The average wage per year (A) = 300×12 = JD 3600 for males and females.

3. The production age begins at the age of 20 and ends at 60 years, with the production of those less than 20 years old assumed to begin at the age 20 years.

4. Fatalities more than 60 years old had no output losses.

5. The mean of each group is considered the age of death for that age group.

6. Lost output period (n) = 60 – mean of age group.

7. Discount rate (r) used for the calculation of the present value is 5%.

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The present value of the lost production per fatality is calculated using the following relationship:

$(P.V) = A\ [(1-(1+r)^{-n}) / r]$

The total corrected present value due to unemployment = (P.V) × (1- 0.12).

Table 4.4 gives the number of casualties of 2009 distributed by age group. The methodology used for the calculations of loss of output due to fatalities is clarified by the following two examples:

1. For fatalities below 20 years old:

- lost output period (n) = 60-20= 40 years.
- Average wage per year = JD 3600.
- Discount rate (r) = 5.0%.
- The present value per fatality $(P.V) = A\ [(1-(1+r)^{-n}) / r]$

$= 3600[(1-(1.05)^{-40}) /0.05]$

= JD 61772.

- Total (P.V) for fatalities below 20 years old = P.V×No. of fatalities

= 61772×226

= JD 13960632

- Total corrected present value due to unemployment = 13960632× (1-0.12)

= JD 12285356.

2. For fatalities of age group (21- 23):

- The mean of the age group = (21+23)/2 = 22
- lost output period (n) = 60-22= 38 years.
- Average wage per year = JD 3600.

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- Discount rate (r) = 5.0%.

- The present value per fatality (P.V) = A $[(1-(1+r)^{-n}) / r]$

$$= 3600[(1-(1.05)^{-38}) /0 .05]$$

$$= \text{JD } 60724$$

- Total (P.V) for fatalities of age (21-23) = P.V × No. of fatalities

$$= 607242 \times 46$$

$$= \text{JD } 2793304$$

- Total correct present value due to unemployment = 13960632× (1-0.12)

$$= \text{JD } 2458108.$$

Table 4.5 shows the results of the calculations which include the present value of the lost production per fatality, the total lost present value of the lost production for each age group and the corresponding corrected (final) present values of lost production taking unemployment into account.

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Table (4.4) Casualties by Age Group for 2009

	Number of Casualties	
Age Group	**Injury**	**Fatal**
5 or Less	1193	78
6 to 8	786	28
9 to 11	1259	50
12 to 14	582	13
15 to 17	539	18
18 to 20	1002	39
21 to 23	1447	46
24 to 26	1567	61
27 to 29	1313	43
30 to 32	1096	41
33 to 35	863	34
36 to 38	671	22
39 to 41	777	37
42 to 44	568	21
45 to 47	420	27
48 to 50	331	21
51 to 53	201	11
54 to 56	228	17
57to 59	166	9
+60	664	60
Total	**15662**	**676**

Source: Ref (3)

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Table 4.5 Corrected Present Value of Output Due to Fatality

Age Group	Mean of Group	Number of Fatalities	Lost Output (Years)	P.V per Fatality(**JD**)	Total Present Value(**JD**)	Corrected Value due to Unemployment(**JD**)
20 or Less	-	226	40	1772	13960632	12285356
21 - 23	22	46	38	60724	2793304	2458108
24 - 26	25	61	35	58947	5595767	4164275
27 - 29	28	43	32	56889	4446254	3152704
30 - 32	31	41	29	54508	3234822	296643
33 - 35	34	34	26	51750	3759522	2548379
36 - 38	37	22	23	48559	1068295	940099
39 - 41	40	37	20	44864	1659966	1460770
42- 44	43	21	17	40587	852319	750041
45 - 47	46	27	14	3535	962148	846690
48 - 50	49	21	11	29903	627963	552607
51 - 53	52	11	8	23268	255948	225234
54 - 56	55	17	5	15586	264964	233168
57 - 59	58	9	2	6694	60246	53016
+60	-	60	0	0	0	0
Total						**36867242**

* Average present value of losses due to death per fatality = JD **39744**

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4.5.1.2 Loss of Output Due to Injuries

The magnitude of losses of output due to a traffic accident injury ranges, depending upon the severity of injuries, between permanent losses as a result of permanent total or partial disablement and temporary losses resulting from loosing production for a certain(not permanent) period of time. The purpose of this section is to estimate the value of both permanent and temporary losses due to injuries.

Permanent Losses

These are the results of injuries causing permanent loss of the person's production capabilities. Such a person may be partially or totally disabled.

In order to estimate the cost of the lost of production due to disability a sample of 390 accident files of different injury severities was investigated and 112 persons were found to be disabled in different percentages of disability as shown in Table 4.6 The sample used is considered representative as it is the largest that could be obtained.

Table (4.6) Distribution of Disabled Persons of the Sample by Degree of Disability and Their Average Age.

Degree of Disability(%)	Disabled Person	
	Number	Average Age
5 - 15	26	30
16 - 30	37	26
31 - 45	19	41
46 - 60	8	38
61 - 75	11	34
76 - 90	7	42
91 - 100	4	37
Total	112	

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Since there is no information or records in the Ministry of Health about the accident severity level or class of injuries, the following assumptions were adopted:

1. No permanent disabilities result from slight injuries.

2. The disabilities result from both serious and medium injuries.

If the number of disable persons exceeds the number of serious injuries, then the remaining disabled persons are assumed to be resulted from medium injuries. According to statistical information for the year 2009, the potential population that might be suffered from risk of disability would be = 4232(medium injuries) +1556(serious injuries) = 5788 and this number will be known as the modified number of injuries.

The method used to calculate the cost of lost of output due to disability is basically the same as that used for fatalities with some changes. The steps of estimating permanent losses due to injuries may be summarized as follows:

1. Calculate the number of disabled persons for the particular degree of disability (N):

N = (no. of disabled persons from sample/390) × modified number

2. Compute the present value of output loss due to disabilities by using the same method used for output losses of fatalities using a reduction factor (f), where f is the mean of degree of disability class:

The present value (P.V) = f× A $[(1-(1+r)^{-n}) / r]$

where A is the average wage per year and assumed to be= JD 3600.

3. Lost output period (n) = 60 – average age.

4. Unemployment rate is 12%.

5. Total (P.V) = (P.V) × no. of disabled persons.

6. Corrected (P.V) = (P.V) × (1-0.12).

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The methodology used for calculations of this item is clarified in the following example for (5-15) % degree of disability:

- Total number of disabilities for this degree = (26/390) ×5788

=386 person.

Average wage per year = A = JD 3600.

Lost output years = n = 60-average age (30) = 30.

Reduction factor (f) = (5+15)/2 = 10%

$(P.V) = f \times A\ [(1-(1+r)^{-n}) / r]$

$= 0.1\times 3600\ [(1-(1+0.05)^{-30}) / 0.05]$

= JD 5534 per disability.

Total present value (P.V) = 5534× 386 = JD 2136124

Corrected Present value due to unemployment = 2136124× (1-0.12)

= JD 1879789.

The calculation results using the above method are shown in Table 4.

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Table (4.7) Total and Average Value of Output Loss Due to Disability

Degree of Disability(%)	Disabled Person		P.V per Disability(JD)	Total P.V(JD)	Corrected P.V Due to Unemployed(JD)
	Number	Average Age			
5 - 15	386	30	5534	2136124	1879789
16 - 30	550	26	13408	7374400	6489472
31 - 45	282	41	16533	4662306	4101829
46 - 60	119	38	25115	2988686	2630044
61 - 75	163	34	35190	5735970	5047654
76 - 90	104	42	33666	3501264	3081112
91 - 100	59	37	46374	2736066	2407738
Total	**1663**		**175829**		**32637638**

It can be seen that the total output loss due to injury in year 2009 is JD 32637638

Average output loss due to disability per person = JD 19,625

For Medium injury = (No. of disabilities - Serious injuries) ×19625/medium injuries

= JD 3,552

A summary of total and average value of output losses due to injury for various casualty classes is shown in Table 4.8.

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Table (4.8) Output Losses Due to Injury for Various Casualties

Casualty Class	No. of Casualty	Average Value For Casualty(JD)	Total Value of Losses
Slight Injury	9874	112.4	1109837
Medium Injury	4232	3552	15032064
Serious Injury	1556	19625	30536500
Total			46678401

Temporary Losses

Injured persons loose some of their productivity for a certain period of time, and then they return to their normal life without any appreciable reduction in their capacity resulting from injury. In order to estimate the value of these losses the following data are needed:

1. Off- work period: the specific period of time through which the victim is unable to work.
2. The number and percentage of injuries who are below or above the production age (less than 20 and more than 60 years).

The statistics showed in Table 4.4 are used to give the following:

1. The total number of injuries is 15662.
2. Number of injuries that are below or above the production age is 6025.
3. Percentage of injuries who are below or above production age = 6025/15662 = 38.5%.

A Sample of 905 injuries with various levels of injury severity was investigated to decide upon an appropriate off work period, and the distribution of injuries by off-work

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period was found to be as shown in Table 4.9. These figures are used to establish the probabilities of each occurring which are then used to calculate the number of injuries in each category. The resulting distribution of injury by off-work period for 2009 and the total lost work day are shown in Table 4.10. For example, the number of injuries who are off-work for 1-7days = (258/905) *15662 = 4465

Using a mean off-work period of 4 days for this group would result in 4465*4 = 17860 lost working days.

Table (4.9) Off- Work Period

	Off - Work Period (day)					
	1 - 7	8 - 14	15 - 21	22 - 28	28 - 60	total
Number of Injuries	258	146	186	175	140	905
Percentage (%)	28.5	16.1	20.5	19.3	15.6	

Table (4.10) Distribution of Injury by Off-Work Period

Off- work Period(day)	**Mean of Group**	**No. of Injuries**	**Total Lost Workday**
1 - 7	4	(I5662×258)/905= **4465**	17869
8 - 14	11	(I5662×146)/905 = **2527**	27798
15 - 21	18	(I5662×186)/905= **3219**	57945
22 - 28	25	(I5662×175/905= **3028**	75720
28 - 60	44	(I5662×140)/905 = **2423**	106618
Total		**15662**	**285950**

Using an average wage per day = 3600/365 = JD 9.86 and an Unemployment rate of 12% would result in a total cost of temporary losses due to injuries =

285950× (1-0.385) × (1-0.12) ×9.86 = JD 1,525,896

Therefore, the average loss per injury =1,525,687/15,662 = JD 97.42.

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4.5.1.3 Medical Costs

An investigation was carried out using the records of insurance companies and hospitals in order to estimate medical costs of traffic accidents. This investigation revealed that, on average, the medical costs were JD 3300, 600 and 360 per fatal, serious and slight injured casualties, respectively.

4.5.1.4 Pain and Suffering

Estimating the monetary value of pain and suffering due to accident causalities is difficult and complicated because of the absence of adequate information and statistics in addition to the human dimension which cannot be valued. Therefore the estimation of this item was based on the results of interviews and personal opinions of judges, lawyers, insurance companies, and medical doctors.

A total of 50 persons of the mentioned professions were interviewed and asked to value pain and suffering for an injured person and his relatives. The following results were obtained as averaged by all the responses:

1. For a medium injury it is about (15-25%) of its total medical cost.

2. For a serious injury it is about (20 -35%) of its medical cost.

3. For death it is JD 10,000.

Using these estimates, the cost of pain and suffering due to the various severity levels were calculated as follows:

(0.15+0.25)/2 × 600 = JD 120 per medium injury

(0.20+0.35)/2 × 600 = JD 165 per serious injury

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4.5.2 Property Damage Costs

This cost is considered a direct major cost item and is generated by all accidents regardless of their severity level. The importance of this item is even greater in countries which import vehicles and their spare parts. The latter involve cost and time as they may not be readily available thereby increasing vehicle detention period. The following parts of this section present the method used and the results of an investigation into this cost item.

Vehicle Damage Repair

When an accident occurs, the vehicles involved will be damaged to a degree that depends on accident severity level. The method used for the estimation for this cost item is based on data collected from several insurance companies where a sample of 1715 files for various severity levels involving different vehicles types were analyzed. Table 4.11 shows the results of this analysis.

Table (4.11) Total and Average Vehicle Damage Repair Costs for Different Severity Levels and Types of Vehicles

Accident Severity Level	Vehicle Type	No. of Vehicles	Total Cost(JD)	Avg. Cost / Vehicle	Avg.Detention(day/veh)
	PC	19	25441	1339	25.2
	Bus	4	6220	1555	16.2
Fatal	Truck	8	13096	1637	10.2
	PC	399	298851	749	11.1
	Bus	46	61318	1333	8.2
Injury	Truck	140	181300	1295	5.1
	PC	930	547770	589	7.4
	Bus	104	94016	904	9.1
PDO	Truck	65	87555	1347	3.3

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Based on the figures of table 4.11 the total and average costs of vehicle damage per vehicle were calculated and the results are summarized in Table 4.12.

Table (4.12) Total and Average Costs of Vehicle Damage Repair per Vehicle

Accident Severity Level	Vehicle Type	No. of involved Vehicles	Avg. Cost per Vehicle Type (JD)	Total Cost(JD)	Avg. Cost per veh. (JD)
Fatal	PC	2172	1339	2908308	**1412**
	Bus	133	1555	206815	
	Truck	624	1637	1021488	
Injury	PC	47718	749	35740782	**928.8**
	Bus	5854	1333	7803382	
	Truck	16984	1295	21994280	
PDO	PC	114154	589	67236706	**762.2**
	Bus	12709	904	11488936	
	Truck	30733	1347	41397351	

Detention period of Repaired Damage Vehicles

The detention period is the time spent in repairing the vehicle damages that results from traffic accident. The method of estimation for this item is based on the data from insurance companies and personal interviews with drivers of buses and trucks which revealed that:

1. The average amount of losses due to detention period per day per bus is JD 25.
2. The average amount of losses due to detention period per day per truck is JD 40**.**
3. The average amount of losses due to detention period per day per passenger car is JD 9 (average cost of a rented car).

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The total and average detention period costs for different severity levels and types of vehicles for 2009 are shown in Table 4.13.

Table (4.13) Total and Average Detention Period Costs for Different Severity Levels and Types of Vehicles

Accident Severity Level	Vehicle Type	No. of involved Vehicles	Avg. Detention Period (day/veh.)	Average Cost per day(JD)	Average Cost/ veh.(JD)	Total Cost(JD)
Fatal	PC	2172	25.2	9	226	492609
	Bus	133	16.2	25	405	53865
	Truck	624	10.2	40	408	254592
Injury	PC	47718	11.1	9	100	4767028
	Bus	5854	8.2	25	205	1200070
	Truck	16984	5.1	40	204	3464736
PDO	PC	114154	7.4	9	67	7602656
	Bus	12709	9.1	25	228	2891298
	Truck	30733	3.3	40	132	4056756

Total and Average Cost of Property Damage per Vehicle are shown in Table 4.14. These figures add the cost of vehicle damage repair and vehicle detention. It can be seen that the grand total cost of Property Damage resulting from accidents that occurred during 2009 amounted to JD 201, 116,871.

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Table (4.14) Total and Average Cost of Property Damage per Vehicle

Accident Severity Level	Vehicle Type	No. of involved Vehicles	Avg. Cost per involved veh.(JD)			Total Cost(JD)	Average Cost per veh. per severity level
			Veh. Damage	Detention Period	Average Cost/ veh.(JD)		
Fatal	PC	2172	1339	226	1565	3399180	
	Bus	133	1555	405	1960	260680	
	Truck	624	1637	408	2045	1276080	**1685**
Injury	PC	47718	749	100	849	40512582	
	Bus	5854	1333	205	1538	9003452	
	Truck	16984	1295	204	1499	25459016	**1063**
PDO	PC	114154	589	67	656	74885024	
	Bus	12709	904	228	1132	14386588	
	Truck	30733	1347	132	1479	45454107	**855**

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4.5. 3 Public Costs

4.5. 3.1 Police Investigation Cost

This cost covers all police activities related to an accident from the moment it happens until the accident file is closed. It is estimated by calculating the wages of policemen who work in the field of traffic accidents, the cost of vehicles and administration costs which are related to the accidents.

The information required to estimate this cost item was obtained from the Traffic Department of Amman / Public Security Directorate (50). It included the average time consumed by policemen and police vehicles for different accident severity levels as shown in Table 4.15.

Table (4.15) Average Time Consumed by Policemen and Police Vehicles for Different Severity Levels

Severity Level	Time Consumed per Accident	
	Man-hour	**Vehicle-hour**
Fatal	35	16
Injury	12	9
PDO	2	1

Source: Ref. (33)

In order to estimate the cost of this item, the following assumptions are adopted:

1. The average wage per person is JD 300 per month (10 JD/day).
2. The average cost of a police vehicle is JD 20 per day.
3. Eight working hours per day.
4. Police administration cost is about 25% of total police costs related to Accidents.

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However, the above estimates do not include some unforeseen costs such as vacations, retirements and special allowances.

Based on previous information the cost of police investigation was calculated and the results are presented in Table 4.16. I t can be seen that the total cost of this item for 2009 accidents amounted to JD 1,153,302.

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Table (4.16) Cost of Police Investigation per Accident Severity Level

Accident Severity Level	No. of Accs.	Total Consumed Time			Admin. Cost(JD)	Total Cost(JD)	Avg. Cost /Accident(JD)
		Man-Day	Veh.-Day	Total Cost of Consumed Time			
Fatal	594	2598.75	1188	28348	7087	35435	59.65
Injury	9640	11460	10845	331500	82875	414375	42.98
PDO	112559	28139.8	14069.8	562794	140698	703492	6.25

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4.5. 3.2 Insurance Administration Cost

These costs include the costs of all activities of the insurance companies generated by traffic accidents such as employee's, wages, rents, training, travelling, and services (water electricity….etc).

According to the annual report issued by the insurance companies for the year 2009, there are twenty eight insurance companies working in Jordan, and the total administration costs for the activities of their vehicle departments amounted to 19,165,221JD. For the purpose of this study this total cost is equally divided on all accidents regardless of their severity or vehicle type resulting in a cost per accident of JD 156.

4.5. 4 Total Accidents Costs

The analysis of accident costs presented in the previous sections revealed a wealth of information which may be summarized as follows:

- The unit cost of each Accident severity Level for The Year 2009 is as summarized in Table 4.17.

Table (4.17) Unit Cost for Each Severity Level

Accident Severity	Death Cost(JD	Sever Injury cost(JD)	Medium Injury cost(JD)	PDO Cost(JD)	Police Investigation Cost(JD)	Insurance Cost(JD)
Fatal Accident	53004	13549	4129	1685	59.65	156
Injury Accident	-	13549	4129	1063	42.98	156
PDO Accident	-	-	-	855	6.25	156

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• The values in Table 4.3 were used in conjunction with Table 4.17 to compute the cost per accident for specific severity using equation 4.1 as follows:

a. cost of fatal accident = 1.14(53004) + 0.52(13549) +1.5 (4129) + 1.57 (1685) +1.0(59.65) + 1.0(156)

= JD 76524

b. cost of injury accident = 0.13(13549) + 1.37(4129) + 1.6(1063) + 1.0(42.98) + 1.0(156)

= **JD 9318.**

c. cost of PDO accident = 1.90(855) + 1.0(6.25) + 1.0 (156)

= **JD 1786.**

Table 4.18 shows a summary of the estimated values of all accident cost elements considered in this study.

Table (4.18) Final Cost for All Accident Cost Elements for The Year 2009

Accident Cost Elements	**JD**
1. Victim Related	
a. Loss of Output due to fatalities	36,867,242
b. Loss of Output due to injuries	48,204,297
c. Medical Cost	12,637,994
d. Pain and Suffering	17,252,720
Sub - total (1)	114,962,253
2. Property Damage	
a. Vehicle Damage Repair	95,584,830
b. Detention Period	105,532,041
Sub - total (2)	201,116,871
3. Administration Cost:	
a. Police Investigation or related activities	1,153,302
b. Insurance Administration	19,165,221
Sub - total (3)	20,318,523
Grand Total (1+2+3)	336,397,647

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Finally table 4.19 shows a summary of the estimated traffic accident costs for the year 2009. The total cost of these accidents amounted to JD 336,397,647 which constitutes 3% of the GDP of Jordan thereby exerting a heavy burden on the national economy of the country.

Table (4.19) Traffic Accidents Cost for the Year 2009

Accident Severity	Number of Accidents	Cost Per Accident in JD	Total Cost (JD)
Fatal Accident	594	76524	45,455,256
Injury Accident	9640	9318	89,825,520
PDO Accident	112559	1786	201, 116,871
Total	**122793**		**336,397,647**

4.6 Estimation of Future Accident Costs

4.6.1 Future Number of Accidents and Related Casualties

The estimation of future accident costs requires that the expected number of accidents in the horizon year be determined first. For this purpose, historical data of accidents and affecting parameters for the period (1995-2009) were used to develop relationships that describe the accident trends and the related fatalities and injuries as shown in figure 4.2. For the purpose of predicting future accidents, it is assumed that the historical trend will continue to operate in the same manner in the future. The following relationships were derived:

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$A = 6,357.91\ X - 12,661.93,\ R^2 = 0.0.98$

$I = 415.15\ X - 814,779.31,\ R^2 = 0.8$

$F = 13.39\ X - 26,375.26,\ R^2 = 0.9$

Where:

X = Years, A = Accidents, I = Injuries, F = Fatalities

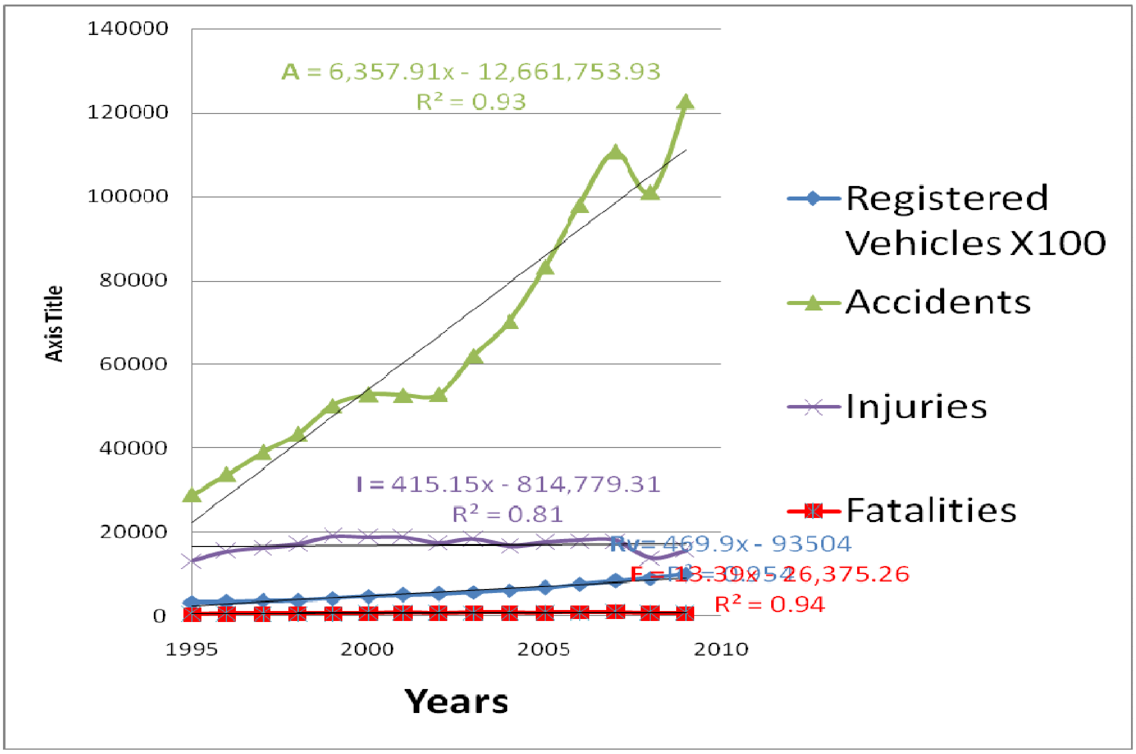


Figure (4.2) Trends of Accidents, Fatalities and Injuries during the Period 1995-2009, **Ref. (3)**

The derived relationships in figure 4.2 were used to estimate the future number of accidents and casualties for the period 2010- 2030. The results are shown in Table 4.20.

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Table (4.20) Estimated Future Accidents and Casualties

Year	Accidents	Injuries	Fatalities
2010	117,645	19,672	539
2011	124,003	20,087	552
2012	130,361	20,502	565
2013	136,719	20,918	579
2014	143,077	21,333	592
2015	149,435	21,748	606
2016	155,793	22,163	619
2017	162,151	22,578	632
2018	168,508	22,993	646
2019	174,866	23,409	659
2020	181,224	23,824	673
2025	213,014	25,899	739
2030	244,803	27,975	806

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4.6.2 Future accident costs

The assumed distribution of accident severity for the year 2030 is shown in table 4.21.

Table (4.21) Predicted Distribution of Accident Severity for the Year 2030

Accident Severity	Number of Accidents	number of Deaths	number of Severity Injuries	number of Minor Injuries	Number of casualties	Number of Involved Vehicles
Fatal Accident	1175	806	551	1588	2945	690
Injury Accident	223309	-	2219	23617	25836	10429
PDO Accident	224484	-	-	-	-	145481
TOTAL	**244803**	**806**	**2770**	**25205**	**28781**	**156600**

The cost per accident of the various severity levels calculated in section 4.5 and shown in Table 4.19 for year 2009 was used to estimate the accident costs of each level and the total cost for all future years.

The coefficient ratios (R1-R6) for year 2030 are shown in Table 4.22.

Table (4.22) Coefficient Ratios (**R1 – R6**)

Accident severity	**Coefficient ratios**				**2030**	
	R1	**R2**	**R3**	**R4**	**R5**	**R6**
Fatal Accident	0.70	0.45	1.30	0.85	1.0	1.0
Injury Accident	-	0.12	1.24	0.55	1.0	1.0
PDO Accident	-	-	-	2.1	1.0	1.0

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Applying equation (4.1) to the data in the above tables we can get the expected total cost of traffic accidents for the year 2030 as shown in Table 4.23.

Table (4.23) Expected Total Cost of Accidents for the Year 2030

Accident Severity	Number of Accidents	Cost Per Accident in JD	Total Cost in JD
Fatal Accident	1224	51312	62,805,888
Injury Accident	19095	2922	55,795,590
PDO Accident	224484	1958	439,539,672
Total	**442080**		**558,138,150**

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CHAPTER FIVE

POTENTIAL OPPORTUNITIES FOR REMEDIAL ACTION

5.1 Introduction

Highways and motor vehicles are so vital to Jordan's national economy that their performance must be a critical and continuing concern. However the reliance on this particular mode of transport has a number of adverse impacts, the most important of which is safety. Road traffic accidents have been diagnosed as" unnecessary" epidemic and besides being serious; the problem is intractable although it is difficult and frustrating to study.

Three main factors are considered when identifying appropriate accident countermeasures. These are:

1. A reliable accident data collection/analysis system.
2. The physical, human, road and traffic characteristics of a country.
3. The level of support offered, and likely to be given by the road using public.

In studying accidents and the effect of remedial measures it is necessary to record, for each accident, all objective factors which seem to contribute to the accident in addition to including accident type. Furthermore, the introduction and eventual effectiveness of many road safety initiatives often depends upon the support received prior to the introduction thus ensuing high compliance.

Another dimension of the problem is that it has no central direction of effort to control due to the fact that a diversity of well intentioned organizations and individuals are involved with road safety and nobody is admitting responsibility for accident and

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causality reduction. However, it is assumed that all parties have been and still are serious about wanting to reduce accidents and their immense drain of national resource.

5.2 Strategies for Better Road Safety

There are two primary strategies and a number of alternative approaches to improve road safety. The primary strategies are:

1. Accident Reduction.
2. Accident Prevention.

Accident Reduction refers to the reduction of the number and severity of accidents on existing roads. Accident Prevention relates to the application of safety principles in new design, whether it be in provision of new roads, or improvement and maintenance of existing roads, which arise out of the need to satisfy traffic or environmental demand.

A key problem is that in many countries, neither the public nor officials perceive the casualties and damage resulting from road accidents to be a top priority nor there is little sustained pressure for corrective action. Despite the great magnitude and impact of the problem, it is tractable and the toll could be greatly reduced if appropriate measures are taken (51).

Given the overwhelming predominance of human error in road accident causation, accident reduction has to be seen as ultimately a matter of influencing human behavior. This task can be approached in two ways:

1. The direct approach which involves, in essence, inculcating in each road user an understanding of standards of safety (both skill and behavior) to conform to those standards as matter of the choice.

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2. The environmental approach which involves creating an environment that reduces the scope for unsafe road user behavior whether he wishes it or not.

Most of the effort directed towards accident reduction has been through the medium of direct approach which most people usually regard as holding the key to road safety. This is the fundamental objective underlying the concepts of road traffic law, road user education and publicity programs and driver training and testing. However, there is an increasing evidence of the contribution to accident reduction made by measures that belong to the environmental approach such as those relating to highway engineering, accident investigation and prevention and vehicle standards.

Accident investigation procedures usually deal with measures that can reduce accidents. But, many of the situations which may increase accidents may be prevented at the outsets by the application of safety principles. So, whilst sustained efforts on accident reduction must continue, it should be acknowledged that "Prevention is better than Cure".

As a result, the emphasis in engineering based road safety work has more recently turned to accident prevention, a strategy which has been centered on " Safety Audit " defined by the British Institution of Highways and Transportation as" The application of safety principles in the provision, improvement and maintenance of roads as a means of accident prevention"

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5.3 Potential Countermeasures

Having reviewed the literature on accidents in chapter 2 as well as accident data from Jordan in chapter 3, this section establishes some ideas or potential opportunities for remedial action. A number of countermeasures that are considered relevant to improve future traffic safety were categorized in accordance with the following goals:

1. Management and coordination.

2. Laws and regulations.

3. Traffic control.

4. Engineering precautions.

5. Public awareness and education.

6. Public transport.

A number of specific countermeasures achieving these goals that are believed and some of them proved to have contributed towards a better road safety are listed in Appendix'A'.

5.4 Attitudes of Road Users towards Accident Countermeasures

5.4.1 Introduction

Earlier work (52) indicated that the introduction and eventual effectiveness of many road safety initiatives often depends on the level of support offered – and likely to be given – by the road using public. Although the likely response of the public will often be an important factor, this is not to say that popularity of an accident countermeasure is the main criterion for deciding about its introduction.

Decisions relating to the timing of the introduction of safety initiatives and the extent and timing of required publicity and education programs would also benefit greatly

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from information about public support. An important factor affecting the public attitude to new safety initiatives and countermeasures will be their perception of how successful or effective a countermeasure might be in terms of making the roads safer for themselves and other road users. However, this perception is likely to be influenced by their perception of personal "Costs" in terms of factors such as travel time and convenience, infringement of liberty and damage to the environment (53).

Based on the above discussion, it is necessary to examine the attitudes of road users towards safety remedial measures in order to evaluate their potential acceptability or such measures. A preliminary investigation was carried out in order to provide an insight into these issues. A questionnaire was designed for this purpose and distributed to a limited random sample of road users. The questionnaire showed in Appendix 'B' aims at collecting information on what representative sample of all types of road user thought about a variety of possible countermeasures.

5.4.2 Method

Thirty eight countermeasures were considered in the questionnaire to assess the public attitude in terms of "effectiveness" and "favorability".

The survey obtained ratings of both how effective they though the measure would be in reducing the number of accidents, and also how much they would be in favor of the measure actually being introduced.

Perceived effectiveness of the different countermeasures was obtained using a five point rating scale having a verbal label as follows:

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1- Backward effect
2- Nothing
3- Little
4- Much
5- Very much

Ratings of how much respondents were in favor of each countermeasure were also obtained using a five point scale as follows:

1- Strongly against
2- Against
3- Neutral
4- Support
5- Strongly support

A limited number of 100 questionnaires were distributed to a random sample of drivers selected from different social and financial sectors in Amman and whichever ages and locations of work they may belong to. This exercise aimed at providing preliminary insight into the attitudes of drivers towards the selected countermeasures.

5.4.3 Results

A summary of the results is shown in Table 5.1which gives the percentage of respondents who thought that each of the 38 countermeasures would be effective and also of those would be in favor of it being introduced. The left column of the table includes those who judged the measure would prevent either "very much" and "much" of accidents while the right column includes those who were either"strongly support" and "support" the countermeasure being introduced.

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Table (5.1) List of Responses to Countermeasures

N0.	Countermeasure	Effective (%)	In Favor (%)
1	Decreasing the maximum speed limits over urban roads	68	80
2	Increasing control of speed limit implementation in urban areas	76	75
3	Increasing max. speed limits along highways	43	52
4	Control intensification on over speed violations in rural roads	73	69
5	Decreasing max. speed limits along highways	36	41
6	Decreasing all max. Speed limits in rainy days	68	72
7	Decreasing max. speed limits during night by 10 Km/h	44	52
8	Increase the number of pedestrian crossing areas	66	80
9	Increase pavement thickness in residential areas	55	41
10	Increase traffic education in schools	82	87
11	Increasing of stoppers in residential areas	50	41
12	Increase highway patrols over roads	57	56
13	Intersection improvements through using traffic signals	65	52
14	Impose the use of reflecting triangle	70	76
15	Impose additional restrictions upon new drivers	53	48
16	Taking in more projects to improve roads	86	87
17	Improving lights on streets in the night	61	76
18	Placing of dangerous crossing signs on high accidents places	79	84
19	Intensify the vehicle inspection for cars	67	64
20	Increase legal age for obtaining driving license	58	52
21	Retesting drivers every five years	28	35
22	Retesting drivers over 65 age every five years	61	66
23	Increase the difficulty level of the driving test	49	42

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N0.	Countermeasure	Effective (%)	In Favor (%)
24	More concentration of the driving test on written part	40	40
25	Increase the penalty value (ticket) for traffic violation	35	23
26	Using radar’s and cameras for controlling speed violation	53	59
27	Using automatic jail penalty against drunk drivers causing accidents	81	82
28	Impose using of safety belt in the back seats passengers	57	55
29	Impose using of safety belt and the like for children in the back seats	62	76
30	Increase the support of general public transportations	88	85
31	Adoption of the points system.	73	70
32	Apply staggered working hours to schools, universities and government departments	78	84
33	Provide safe sidewalks for pedestrians free of obstacles.	89	91
34	Reconsideration of the openings in the median islands for highways and main roads and closing the unjustified among it.	67	69
35	Maintenance of traffic signs and removes the obstacles that obscure vision.	69	77
36	Marking and painting for roads and sidewalks in accordance with the requirements of traffic safety.	75	80
37	Removing s the obstacles from medians that restricts sight distance like trees.	82	85
38	Increase the number of play areas, parks, and stadiums in residential areas.	80	87

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Two indices were introduced to obtain the ranking scores for each countermeasure. The indices "effectiveness index" and "favorability index" represent the arithmetic mean of all the rating responses scored from 1 to 5 with the lower indices given a lower ranking. A lower ranking therefore indicates that the measure was perceived as being likely to result in a greater accident reduction or that its introduction would be more "welcome".

The five highest and lowest ranked countermeasures for "effectiveness" and "favorability" are listed in Tables 5.2 and 5.3 respectively. The five measures that were seen by road users as very effective in reducing accidents include:

1. Improving lights on streets in the night.
2. Taking in more projects to improve roads.
3. Increase the support of general public transportations
4. Provide safe sidewalks for pedestrians free of obstacles.
5. Increase the traffic education in schools.

The five most favorable ratings were:

1. Improving lights on streets in the night.
2. Taking in more projects to improve roads.
3. Increase the traffic education in schools.
4. Maintenance of traffic signs and removes the obstacles that obscure vision.
5. Placing of dangerous crossing signs on high accidents places.

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Table (5.2) Highest and Lowest Countermeasures on "Effectiveness Index"

Countermeasure	Effective Index	Rank
Highest:		
Provide safe sidewalks for pedestrians free of obstacles	4.65	**1**
Taking in more projects to improve roads	4.56	**2**
Increase the support of general public transportations	4.52	**3**
Improving lights on streets at night	4.47	**4**
Increase the traffic education in schools	4.37	**5**
Lowest:		
Concentrate of the driving test on writing part	2.89	**1**
Increasing max. speed limits over highways	2.94	**2**
Retesting drivers every five years	3.03	**3**
Increase the difficulty level of the driving test	3.04	**4**
Increase the number of pedestrian crossing areas	3.21	**5**

Table (5.3) Highest and Lowest Countermeasures on "Favorability Index"

Countermeasure	Favorability Index	Rank
Highest:		
Provide safe sidewalks for pedestrians free of obstacles	4.83	**1**
Taking in more projects to improve roads	4.68	**2**
Increase the support of general public transportations	4.67	**3**
Maintenance of traffic signs and removes the obstacles that obscure vision.	4.67	**4**
Placing of dangerous crossing signs on high accidents places	4.66	**5**
Lowest:		
Concentrate of the driving test on writing part	2.49	**1**
Increase the number of pedestrian crossing areas	2.85	**2**
Increase the stoppers in resedential areas	3.02	**3**
Retesting drivers every five years test	3.03	**4**
Increase the penalty value (ticket) for traffic violation	3.16	**5**

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Tables 5.2 and 5.3 show that there was considerable agreement between the perception and rating of a countermeasure's likely effectiveness and favorability for its actual introduction. However, certain countermeasures did not appear to follow this pattern. Table 5.4 lists some of those measures showing the discrepancy between two ratings.

Table (5.4) Discrepancy between Effectiveness and Favorability

Countermeasure No.	Effectiveness Index	Favorability Index	Difference
1	4.1	4.22	- 0.12
2	3.98	4.1	- 0.12
4	3.93	3.78	+ 0.15
6	3.97	4.22	- 0.25
8	3.79	4.14	- 0.35
13	3.59	3.27	+ 0.32
20	3.38	3.35	+ 0.03
26	3.6	3.39	+ 0.21

Considering both indices, countermeasures that have the highest merging between efficiency and favorability were identified and ranked as shown in Table 5.5.

Table (5.5) Highest Effective and Favorable Countermeasures

No.	Countermeasure
1	Provide safe sidewalks for pedestrians free of obstacles
2	Taking in more projects to improve roads
3	Increase the support of general public transportation

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CHAPTER SIX

CONCLUSIONS, RECOMMENDATIONS AND FUTURE WORK

6.1 Conclusions

Traffic safety in Jordan is a serious problem, with very large socio-economic costs that impose a great impact on national economy. The overall aim of this research was to identify the nature, characteristics and costs of RTA in the country in order to be able to identify the most appropriate countermeasures.

The study comprised a comprehensive investigation of road safety in Jordan and the results, based on a detailed analysis of accident data, show that the state of road safety in Jordan has generally deteriorated over the last few years. The accident rate, the number of fatalities and the number of injuries have all steadily increased up to year 2007 then fluctuated for the last two years. The fatality rates per 100,000 populations and per 10,000 registered vehicles were both found to be high compared to developed countries.

The temporal variation of RTA showed that the highest number accidents occur during afternoon rush hour (1400-1500), on Thursday and during the summer months (July, August and September). Further analysis of RTA data showed that the highest percentages of accidents occurred in the capital (68.7%) and involved passenger cars 68.4% of total.

The casualty profile showed that fatalities represent 4% of total casualties while serious injuries represent 10% and the remainders (86%) were slight injuries. Females were less involved in casualties than males and the highest age groups involved were those between 15 and 45 years (62.8%) with the age group 24-26 years having the highest

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fatalities (9%). The highest number of pedestrian accident occurred between 1300-1600 hours which coincide with the educational institutions (schools and universities) letting out students.

Analysis of accident costs revealed that RTA that occurred during 2009 had a total estimated cost of over JD 336 million which constitute about 2.3% of the GDP of Jordan. Property Damage Only accidents has the largest cost share (59.8 %) followed by injury accidents (26.7 %) then fatal accidents (13.5 %).

Predictions of future number of accidents and their costs showed that the magnitude of safety problem will grow over the years to an estimated cost of over JD 558 million in the year 2030. However some of these costs can be avoided by learning from experience of more motorized countries and intervening to stop personal safety getting as bad as it did in more motorized countries before the latter took action to improve traffic safety.

A number of potential countermeasures were suggested and evaluated through a field survey to measure their effectiveness and favorability as perceived by road users. Considering both effectiveness and favorability indices three countermeasures were identified to have the highest merging of both indices. These are:

1. Provide safe sidewalks for pedestrians free of obstacles.
2. Taking in more projects to improve roads.
3. Increase the support of general public transportation.

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6.2 Recommendations

6.2.1 General

The results of the study reveal that accident and casualty rates in Jordan are alarmingly high compared to those in many developed countries. This calls for the need to explore potential opportunities for remedial action and to develop a national strategy in order to improve the road safety situation.

Despite the fact that some improvement has been made, Jordan still have a serious traffic safety problem suggesting that there still quite some way to go in understanding the nature of the problem and how it should be addressed. It should be noted that a safety program that achieve major benefits in one country, may not be that successful in another country, due to the complexity of the interrelation ships that exist between the traffic variables and driver attitudes, and because each country have its own sound and robust process for developing safety.

A traffic safety policy or strategy should not be focused on road users, but should involve a substantial elementary of engineering (roads and vehicles) as well as education and enforcement. It should involve getting the community to recognize that there is a problem and to take ownership of the problem, so that a safety culture develops within the community. It should also involve getting all government transport and health authorities to integrate and coordinate their traffic safety activities. In addition special attention should be given to the needs of vulnerable road users(pedestrian, cyclists, children and elderly).

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It is of utmost importance that any safety policy or strategy should involve a careful evaluation of what is done. There is no point in wasting funds implementing or continuing ineffective programs.

It is desired to improve both safety and sustainability. Therefore, it is important to recognize the conflict which can exist between these goals, and to ensure the safety and sustainability policies and strategies are well integrated and coordinated. One approach which appears to offer considerable potential for improving both safety and sustainability is travel demand management which include encouraging greater use of public transport, and encouraging walking and cycling where there are safe facilities for pedestrians and cyclists (54).

6.2.2 A Recommended National Strategy For Jordan

In view of the above discussion, a specific strategy using the experience of developed countries is required and is recommended to be adopted for Jordan as detailed below.

The strategy is applied in the form of a National Road Safety plan. The purpose of this strategy is to establish a coordinated approach which will assist in devising the most appropriate solutions for the road safety problem, implementing these solutions and evaluating them to improve future program design.

• Main Features

The main features of the strategy include:

1. Coordination of resources, activities and ideas across all sectors.

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2. The creation of database containing a description of all the existing programs freely accessible to any department or organization in Jordan with interest in road safety.
3. The definition of target areas for road safety programs to achieve the best results for the least costs.
4. Annual revision of both the strategy and the targets in order to create appropriate set of guidelines for the situation as it develops.

• Objectives

The main objectives of the strategy are:

1. Assisting economic development;
2. Assisting safety and personal security;
3. Improving access and mobility;
4. Protecting and promoting public health;
5. Ensuring environmental sustainability.

• Goals

The strategy will have the following short and long term goals:

1. The short term goal- over the next five years are:

- Achieve a 20% reduction in the number of accidents, resulting casualties, hospitalizations and property damage.
- Develop a process by which communities can share ownership of road safety objectives.

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- Include road safety in land use planning and resource management requirements.
- Achieve reductions in the level of traffic noise, Carbon dioxide (CO_2) emitted and leaded petrol consumed.

3. The long- term goal is to achieve a level of safety on the roads of Jordan which is equivalent to those of the safest countries (with comparable levels of car ownership), via a change in community attitudes and creation of a "safety culture".

• Themes

The strategy groups safety issues under four themes, reflecting the traditional concept of a system comprising user, vehicle and road environment sub- systems as follows:

1. Safer people
2. Safer roads
3. Safer vehicles
4. Safer management

Within the above themes, targets have been selected for detailed attention. These targets represent the problem areas in road safety which must be addressed in the process to improve safety performance. It is considered that the objectives of the above strategy can be achieved **through better management, coordination and legislation together with increase in allocated resources.**

Community ownership is considered a fundamental requirement for improved road safety with local communities being able to participate in setting local priorities, making decisions, and implementing and evaluating their road safety program. This can be achieved by establishment of **road safety coordinating committees** to coordinate local

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road safety interventions, promote community awareness and facilitate community participation in road safety activities.

Based on findings of the World Bank Report (55), a major problem surrounding current attempts to improve safety is that when equipment is installed, authorities rarely study the effect and they rarely have data on accidents before it was installed. This confirms the value of the following corrective measures to reduce the uncertainty:

- Introduce or improve data collection and analysis system.
- Form official, national coordinating committees and a small team working full time on road safety.
- Train traffic engineers to analyze accidents, conduct limited safety studies to identify the most important problems. Convince officials to take action and design and evaluate corrective measures.

Finally, **a range of relatively low-technology, low-cost safety measures** that have been widely used in developed countries should be consistently applied in Jordan in particular, the potential countermeasure that proved to be high. The Key Strategy to be pursued in the redirection of available resources towards measures which are demonstrably cost-effective in terms of casualty reduction. The concept of cost-effectiveness does not mean that saving money is more important than saving lives. Rather it is simply a matter of achieving maximum casualty reduction by deployment of the resources at our disposal.

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6.3 Future Work

Further research needs to be carried out to provide more insight into the road safety problem in Jordan, which can help to identify better solutions to reducing the number and rates of accidents and resulting casualties. The following research topics are suggested to achieve these goals:

1. More in-depth investigation is required regarding the actual causes of accidents and actual driving behavior, may be by monitoring drivers' behavior using CCTV.
2. Similar investigation is required to study safety aspects of vulnerable road users (such as cyclists and pedestrians) in order to determine their needs and introduce their required facilities.
3. A monitored before-and-after study is suggested to evaluate alternative improvement programs.
4. A more detailed analysis of accident costs and their estimation that incorporates the external cost elements is suggested. Such estimates provide a more convincing evidence for the decision makers about the magnitude of the problem and the urgent need for remedial action.

The above proposed research topics require reliable data and therefore an on-site investigation at the accident site is recommended in order to collect more accurately details of the accident and its contributory factors.

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APPENDIX 'A'

Countermeasure	Goal
First: Management and coordination	
(A). Formation of sub-committees as follows:	
1. Establish a permanent coordinating committee in the ministry of interior includes its membership representatives from:: - Public Security Directorate. - Ministry of Public Works and Housing. - Ministry of Municipalities. - Great Amman Municipality. - Private Sector.	Constant a continuous coordination between all the involved parties in traffic safety must be maintained. The parties' efforts must be united in order to maintain a proper order in the private sector. Meetings must be carried out once a month, or as the need arises.
2. A permanent public media committee to raise public awareness must have the following members on its board: - Public Security Directorate. - Ministry of Public Works and Housing. - Ministry of Municipalities. - Great Amman Municipality. - Private Sector. - Media. - Ministry of Education.	To establish a media plan to define programs and media facilities in coordination with other committees on this matter.
(B). Review the starting official working hour's for ministries, universities and schools (council of ministers). **(c).** Provide a collective means of transport for staff of ministries and government institutions (ministry of finance). **(D).** Encourage large companies which have 50 or more employees to provide transit mode for them.	To find a disparity in the movement of staff and students in order to reduce traffic congestion

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Countermeasure	Goal
Second: Laws and regulations	
1. Urgently adopt the law of the Supreme Council for traffic safety **2.** Adoption of the points system. **3.** Increase the value of all types of traffic tickets.	Carry out the functions of the Supreme Council as stated in the draft law (council of ministers, House of Representatives).
4. Reduce the speed limit by 10Km/hour at night. **5.** Reduce all speed limits in winter. **6**. Reduce the speed limit in urban areas.	Achieve deterrence through suspension of driving licenses to reduce pedestrian's accidents.
7. Activate the text of article 22/b of the traffic law on the allocation of 40% from the licensing fees to the municipalities require that these amounts will be disbursed in order of traffic safety (council of ministers, ministry of finance).	Activate and maintain the roads within the municipalities areas
8. Activate the text of article 12/c of the traffic law on the allocation of 5% of license fees for the management of licensing, vehicles and traffic departments to develop its performance.	To develop the necessary equipments and raise the efficiency of employees in traffic departments.
9. Reconsider the age at which the person can get a driving license for private and transit vehicles. **10.** More concentration on the yearly technical test of vehicles. **11.** Recosider of license exam to make it harder especially the written part. **12.** Reevalution for licenses every 5 years to age group above 65. **13.** Activate the jail penalty for alcoholic drivers. **14.** Using the children seat, and safety built in back seats is forced and guaranteed by law.	Guarantee the level of awareness to the drivers.

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Countermeasure	Goal
Third: Traffic control (Public Security Directorate, Ministry of Public Works and Housing, Great Amman Municipality)	
1. Increase the automated control such as cameras and radars in hazardous locations.	To reduce speeds and wrong passing maneuverings
2. Focusing on the follow-up of hazardous violations that cause the occurrence accidents (taking the wrong lane, over speed, giving priority…., etc).	To reduce the mobile violations which are the most important causes of dangerous accidents?
3. Intensify supervision of the hidden control through traffic detectives. **4**. Increase the traffic patrols on highways.	

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Countermeasure	Goal
Fourth: Engineering precautions (Public Security Directorate, Ministry of Public Works and Housing, Great Amman Municipality, ministry of municipalities)	
1. Continue in the processing of hazardous locations by committee that have been formed to this reason.	Reduction of collision, turnover, pedestrian accidents, increase the visibility in roads
2. Continue in the maintenance of roads and highways through a comprehensive maintenance program.	Enhance the geometry of intersections, loops traffic signals…, etc.
3. Continue in the engineering improvements for roads and intersections where traffic jams, which may be lead to accidents.	
4. Rehabilitation of roads and highways through:	
- Increase the number of warning, guidance, and mandatory signs. - Marking and painting for roads and sidewalks in accordance with the requirements of traffic safety. - Create and promote safe crossing areas for pedestrians according to specifications. - Provide safe sidewalks for pedestrians free of obstacles.	
- Enhance the current lighting system that being used in roads.	
- Adopt the principle of speed by region.	
- Maintenance of traffic signs and removes the obstacles that obscure vision.	
- Reconsideration of the openings in the	

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Countermeasure	Goal
median islands for highways and main roads and closing the unjustified among it. - Increase the use of means for reducing speed such as artificial obstacles, intermittent lights… etc, especially in residential areas. **5.** Increase the number of play areas, parks, and stadiums in residential areas. **6.** Emphasis on the provision of car parking when giving permits for all type of buildings. **7.** Re-consider the terms of license of some facilities such as wedding halls, cafes, fuel stations malls according to traffic safety. **8.** Encourage the owners of unused lands to use it as playgrounds and temporary parking within the municipalities' borders.	Reduction of collision, turnover, pedestrian accidents.
Fifth: Public awareness and education (Public Security Directorate, Ministry of Public Works and Housing, Great Amman Municipality, ministry of municipalities) **1.** Establish of traffic safety clubs in private and public universities (Ministry of high Education). **2.** Consider the traffic law as an optional text in private and public universities (Ministry of high Education). **3.** Include the traffic concepts in schools curriculum.	To increase the level of awareness among university and school students.
4. Emphasize the role of media in allocating educational programs for public awareness. 5. Increase the number of brochures to increase awareness throughout the year, according to the requirements of seasons and events.	To increase the level of awareness among the citizens.

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Countermeasure	Goal
<u>Sixth</u>: <u>Public transport</u> (Ministry of transport, Great Amman Municipality) Speed up the development of the public transport sector in order to encourage citizens for the employment of public transport by providing a convenient means of mass transit with regular frequencies.	Limit the use of private vehicles and reduce the number of cars on the roads which causes traffic jams and accidents.

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APPENDIX 'B'

<u>بسم الله الرحمن الرحيم</u>

الجامعة الاردنية

كلية الهندسة والتكنولوجيا

قسم الهندسة المدنية

أخي المواطن الكريم : تمثل هذه الاستبانة محاولة لمعرفة رأيكم حول بعض الحلول المقترحة للتخفيف من حوادث المرور في المملكة.

أرجو التكرم بقراءة كل عبارة من عبارات الأستبانة واختيار الاستجابة المناسبة وذلك بوضع إشارة (√) تحت التدريج المناسب . علما بأن رأيكم حول كل عبارة (حل) يتكون من قسمين: القسم الاول (على يمين كل عبارة) وهو لمعرفة تقديركم المناسب في كفاءة الحل ومدى فعاليته وتأثيره , والقسم الثاني (على يسار كل عبارة) وهو لمعرفة مدى تأييدكم ودعمكم في تطبيق الحل واستجابتم له.

هذه المعلومات قد تكون ذات فائدة عامة, لذا نرجو التكرم بملئ الاستمارة بعد قراءة كل عبارة واختيار الاستجابة (على الجهتين) التي تعتقد فعلا أنها التقدير المناسب ...

وشكـــــــــــرا لتعاونكم...

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"تقدير الكفاءة والفعالية" **"تقدير الدعم والتأييد"**

كثير جدا كثير قليل لاشئ لايقلل بل يزيد		**أدعم بشدة أدعم محايد ضد ضد جدا**
....	1. تخفيض حدود السرعة القصوى على الشوارع في المناطق الحضرية.	....
....	2. زيادة الرقابة على تطبيق السرعة القصوى في المناطق الحضرية.	....
....	3. زيادة حدود السرعة القصوى على الطرق السريعة.	....
....	4. تشديد الرقابة على مخالفات السرعة الزائدة خصوصا في الطرق الخارجية والسريعة.	....
....	5. تخفيض حدود السرعة القصوى على الطرق الخارجية والسريعة.	....
....	6. تخفيض كل حدود السرعة القصوى في الأيام الماطرة.	....
....	7. تخفيض حدود السرعة القصوى أثناء الليل بقدار (10 كم/ساعة) عما هو في النهار.	....
....	8. زيادة عدد مناطق عبور المشاة.	....
....	9. زيادة المطبات في المناطق السكنية.	....
....	10. زيادة التثقيف المروري في المدارس.	....
....	11. زيادة الدعاية والاعلان عن سلامة المرور (راديو, تلفزيون, صحف, ...الخ)	....
....	12. زيادة دوريات الشرطة على الطرق.	....
....	13. تحسين التقاطعات بالاكثار من استخدام الاشارات الضوئية.	....
....	14. أن يكون اجباري للسيارة المعطلة بوضع المثلث العاكس للتنبيه.	....
....	15. وضع قيود اضافية على السائقين الجدد (كحدود سرعة أقل مثلا).	....
....	16. ادخال مشاريع اكثر لتحسين وضع الطرق.	....
....	17. تحسين الاضاءة على الشوارع ليلا.	....
....	18. وضع علامة "تقاطع خطر" عند الاماكن الخطرة والتي تكثر فيها الحوادث.	....
....	19. زيادة التركيز على الفحص الفني للمركبات (فحص أدق).	....

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تقدير الكفاءة والفعالية" **"تقدير الدعم والتأييد"**

كثير جدا كثير قليل لاشئ لايقلل بل يزيد		**أدعم بشدة أدعم محايد ضد ضد جدا**
....	20. زيادة العمر القانوني للحصول على رخصة القيادة.	....
....	21. اعادة فحص (تأهيل) السائقين كل خمس سنوات.	....
....	22. عمل فحص قيادة كل خمس سنوات للسائقين ذوي الأعمار فوق 65 سنة.	....
....	23. جعل اختبار القيادة أصعب للاجتياز (النجاح).	....
....	24. جعل اختبار القيادة يركز على الجزء التحريري المتعلق بالقيادة.	....
....	25. زيادة قيمة الغرامة على المخالفات.	....
....	26. استخدام الرادار والكاميرات لضبط مخالفي السرعة.	....
....	27. ادخال عقوبة السجن الاوتوماتيكي للسائقين المتسببين في الحوادث الخطرة تحت تأثير السكر.	....
....	28. جعل حزام الامان اجباري للركاب في المقعد الخلفي.	....
....	29. جعل استخدام حزام الامان أو ماشابه ذلك للأطفال في المقعد الخلفي اجباري.	....
....	30. زيادة الدعم لوسائط النقل العام لتكون أسعارها أقل.	....
....	31. تفعيل استخدام النقاط والحرمان المؤقت من رخصة القيادة.	....
....	32. ايجاد تباين في بدء الدوام الرسمي بين المدارس والدوائر الرسمية.	....
....	33. توفير أرصفة كافية وعريضة (آمنة) للمشاه.	....
....	34. الغاء فتحات الالتفاف على الطرق السريعة والرئيسيه.	....
....	35. ازالة العوائق التي تحجب رؤية الشواخص المرورية.	....
....	36. تحسين نوعية الدهان المستخدم على الطرق لتوجيه السائقين.	....
....	37. تقليم الاشجار المزروعة داخل الجزر الوسطية على الطرقات بحيث لا تعيق الرؤية.	....
....	38. زيادة عدد الساحات المخصصة للترفيه والاصطفاف في المدن.	....

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مستقبل السلامه المروريه في الاردن واثرهـــا

على الاقتصاد الوطنـــــي

اعـداد

المهندس عماد محمد الحياري

اشراف

استاذ. دكتور خير سعيد جدعان

ملخص

تشير الاحصائيات الى ان معدل الوفيات لكل 10.000 مركبه في الاردن يصل الى اكثر من 10 اضعافه في الدول المتقدمه مثل اليابان وسويسرا والسويد وبريطانيا وهولندا ، وان عدد الحوادث يظهر تزايدا" سنويا" مستمرا" حيث بلغ عدد الحوادث المرورية في عام 1992 (20.970) حادثا" نتج عنها 388 حالة وفاه ، و في عام 2007 زاد عدد الحوادث ليصل الى (110.630) حادثا" (خمسة اضعاف) نتج عنها 992 حالة وفاه على الرغم من ان عدد المركبات لم يتجاوز عن (84.933) مركبه حيث بلغت التكلفة التقريبية لهذه الحوادث (280) مليون دينارا" اردنيا".

يهدف هذا البحث الى الوصول الى فهم افضل لخصائص وانماط الحوادث في الاردن وتقييم اثرها على الاقتصاد الوطني، واستخدام النتائج لوضع الخطوط العريضة لخطط تحسين السلامة المرورية من خلال وضع بعض الاجراءات الوقائيه والتي تم تقييمها بدراسة نظرة مستخدمي الطرق تجاه فعالية ومدى تقبل هذه الاجراءات للوصول الى ان انجع الحلول .

تعرض هذه الدراسه النتائج التي تم الوصول اليها من جمع البيانات المتوفره لدى الهيئات والمؤسسات المعنيه مثل المعهد المروري الاردني ووزارة الصحه وشركات التأمين وغيرها ، اضافة الى الاستبيانات والإتصالات والمقابلات الشخصيه مع المعنيين.

تبين انه على الرغم من اتخاذ بعض الاجراءات باتجاه الوصول الى مستوى افضل من السلامه المرورية الا ان الاردن لا يزال يعاني من مشكلة حقيقية في هذا المجال وانه لا يزال الطريق طويلا" لفهم طبيعة المشكله والطريقة المثلى لمواجهتها اذ تبين الدراسة ان كلفة الحوادث لعام 2009 بلغت (336) مليون دينار مرشحة للوصول الى 558 مليون دينار في العام 2030.

تم ادراج تفاصيل خطة وطنية مقترحه للسلامة المرورية في الاردن ، واضافة الى اهداف الخطه قصيرة المدى فإنها تضع نصب أعينها اهدافا" بعيدة المدى للوصول الى مستوى يمكن مقارنته بأفضل الدول من حيث سجل السلامه المروريه من خلال تحسين ثقافة السلامة

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المرورية والسلوكيات لدى الاشخاص، وقد تم الوصول الى مجموعة من الاجـراءات الوقائيـة التي لاقت قبولا" من قبل مستخدمي الطرق من حيث الفعالية والدعم في حال تبنيها مـن قبـل الجهات المعنيه، كما تم اقتراح ابحاث اخرى للوصول الى فهم اعمق للمشكله في الاردن.

ستؤثر نتائج هذه الدراسه اذا ما تم تطبيقها على السياسه المستقبليه نحو الثقافه وتدريب السائقين وتطبيق القانون لتحقيق الاهداف.

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